

United States Environmental Protection Agency



# **Contaminated Sites Multi-Year Research Plan**

**FY2003 Edition**

**Office of Research and Development**

**June 2003**

**Not Yet Externally Peer Reviewed**

The Office of Research and Development's (ORD) multi-year plans (MYPs) present ORD's proposed research (assuming constant funding) in a variety of areas over the next 5-8 years. The MYPs serve three principal purposes: to describe where our research programs are going, to present the significant outputs of the research, and to communicate our research plans within ORD and with others. Multi-year planning permits ORD to consider the strategic directions of the Agency and how research can evolve to best contribute to the Agency's mission of protecting human health and the environment.

MYPs are considered to be "living documents." ORD intends to update the MYPs on a regular basis to reflect the current state of the science, resource availability, and Agency priorities. ORD will update or modify future performance information contained within this planning document as needed. These documents will also be submitted for external peer review.

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## Acronym List

AMD	Acid mine drainage	NERL	Plan
APG	Annual Performance Goal		National Exposure Research
APM	Annual Performance Measure		Laboratory
BTEX	Benzene, toluene, ethylbenzene, and Xylene	NHEERL	National Health and Environmental Effects Research Laboratory
CA	Corrective Action	NIEHS	National Institute of Environmental Health Sciences
CAHs	Chlorinated aliphatic hydrocarbons	NOAA	National Oceanic and Atmospheric Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980	NRMRL	National Risk Management Research Laboratory
DNAPLs	Dense non-aqueous phase liquids	OERR	Office of Emergency and Remedial Response
DOD	Department of Defense	ORD	Office of Research and Development
DOE	Department of Energy	OUST	Office of Underground Storage Tanks
FTE	Full-time equivalent	OSWER	Office of Solid Waste and Emergency Response
GCL	Geosynthetic clay liners	PAH	Polynuclear aromatic hydrocarbon
GPRA	Government Performance and Results Act	PCB	Polychlorinated biphenyl
GW/SW	Ground water/surface water	RCRA	Resource Conservation and Recovery Act
HSRC	Hazardous Substance Research Center	SCCWRP	Southern California Coastal Water Research Project Authority
ITRC	Interstate Technology and Regulatory Cooperation Working Group	SITE	Superfund Innovative Technology Evaluation
LF	Landfill	SVOC	Semi-volatile organic compound
LUST	Leaking Underground Storage Tanks	TCE	Trichloroethylene
MNA	Monitored natural attenuation	TRV	Toxicity Reference Value
MNR	Monitored natural recovery	USACE	United States Army Corps of Engineers
MTBE	Methyl tertiary-butyl ether	USAF	United States Air Force
MYP	Multi-Year Plan	USFW	United States Fish and Wildlife Service
NAPL	Non-aqueous phase liquid	USGS	United States Geological Survey
NASA	National Aeronautics and Space Administration	USN	United States Navy
NCEA	National Center for Environmental Assessment	VOC	Volatile organic compound
NCER	National Center for Environmental Research		
NCP	National Oil and Hazardous Substances Pollution Contingency		

## Introduction

The Office of Research and Development (ORD) uses multi-year planning to chart the direction of our research program in selected topic areas over a period of approximately five to ten years. This approach promotes ORD's focus on the highest priority issues and provides a roadmap to achieving our long-term research goals. The purpose of the multi-year plans (MYPs) is to provide a framework integrating research across ORD's Laboratories and Centers and Government Performance and Results Act (GPRA) goals in support of the Agency's mission to protect human health and to safeguard the natural environment. MYPs are composed of two major components:

(1) a narrative description of the plan and (2) a matrix of goals and measures (annual performance goals (APGs) and associated annual performance measures (APMs)) needed to meet the long-term goals identified in the plan. The MYP matrices relate the outputs in a particular year with the APGs they support, even if the APG is in an outyear. These goals and measures are based on total annual resource levels for the topic area and will not exceed the resource level proposed in the most recent President's Budget.

By helping to identify the impact of potential planning decisions, MYPs aid in the evaluation of research options, and foster the integration of strategic risk-based environmental protection and anticipation of future environmental issues. They also allow for a more comprehensive understanding of changes needed to emphasize a new direction or accelerate an existing program. MYPs are updated periodically to reflect changes in Agency strategic thinking, the realities of available resources, and the current state-of-the-science. The MYPs provide a link between the strategic plans and annual plans, showing how we intend to meet our outyear goals. MYPs also link the research strategy and research plans to show how ORD conducts research in an integrated fashion to reach major milestones and end points.

The Contaminated Sites MYP describes ORD problem-driven research supporting three Office of Solid Waste and Emergency Response (OSWER) trust fund programs for which research is authorized: Superfund (SF), Leaking Underground Storage Tank Corrective Action (LUST CA) and the Oil Spills Program. Approximate research funding (FY04 President's Budget) for each trust fund is: \$36M for Superfund, \$600K for LUST and \$900K for Oil Spills. These resources include approximately 111 FTEs. Portions of the Superfund resources are designated for funding Congressionally-directed programs, including the Hazardous Substance Research Centers and the Superfund Innovative Technology Evaluation (SITE) program. This plan is written on the assumption that the resources in each trust fund remain constant each year. Research related to Brownfields is authorized under the Small Business Liability Relief and Brownfields Revitalization Act of 2002, but resources for research are not specified in the FY04 President's Budget. The initial efforts that have been funded through intraagency funding transfer from OSWER to ORD are reflected in this plan and an appendix describes the program that would be conducted should additional resources be appropriated under the new law.

Principal clients of research on contaminated sites include the Office of Emergency and Remedial

## **ORD multi-year plans**

Goal 1 - Clean Air

**Air Toxics; Particulate Matter; Tropospheric Ozone**

Goal 2 - Clean and Safe Water

**Drinking Water; Water Quality**

Goal 3 - Preserve and Restore the Land

**Contaminated Sites; RCRA**

Goal 4 - Healthy Communities & Ecosystems

**Ecological Research; Endocrine Disruptors; Global Change; Human Health; Mercury; Safe Communities; Safe Food**

Goal 5 - Compliance & Environmental Stewardship

**Economics and Decision Sciences; Pollution Prevention**

Response (OERR), OERR's Oil Program Center, Office of Underground Storage Tanks (OUST), Office of Brownfields Cleanup and Redevelopment; regional and state staffs who implement these programs; regulated and responsible parties; and contractors who perform site-specific assessment and remediation.

Research conducted in other multi-year plans augments the research in this MYP. The Human Health, Ecological Research, and Economics & Decision Sciences MYPs describe core research that advances the science underlying all Agency decisions; results of that research inform our program-driven research and influence decisions made by program offices. The Contaminated Sites MYP is most closely linked with the Resource Conservation and Recovery Act MYP. The two plans comprise research that directly supports the Agency's Land Goal and address waste management, resource conservation, and site cleanup issues that are common across the land programs.

This edition of the Contaminated Sites MYP was produced by the Waste Research Coordination Team, comprising ORD, OSWER, and Regional staff. Members of the writing team solicited input and reviews from their organizations during the update process and brought input from other stakeholders via their professional associations. Documents that contributed to the development or revision of this plan include:

- EPA Draft Strategic Plan, <http://www.epa.gov/ocfo/>
- Office of Research and Development Strategic Plan, EPA/600/R-01/003 and 1997 Update to ORD's Strategic Plan, EPA/600/R-97/015
- ORD Waste Research Strategy, EPA/600/R-98/154
- Superfund's Future: What Will It Cost? Resources for the Future, 2001, ISBN 1-891853-39-2
- MYP guidance
- compilations of program office needs and formal and informal discussions with clients

EPA's Strategic Plan sets overall goals and specific targets for programs to achieve. The Land Goal within the strategic plan identifies the targets for the trust fund programs that this MYP supports. The targets help us determine where ORD can contribute to achieving the goals. OSWER has also set program priorities that we have recognized in revising the Contaminated Sites and RCRA MYPs. These include Revitalization and One-Cleanup Program, aimed respectively at having land use/reuse in mind from project inception and at having consistency and complementarity among land programs. The ORD Strategic Plan and the SAB-reviewed Waste Research Strategy provide the global and goal-specific directions for setting research priorities. The Resources for the Future report provides insight into additional drivers that may influence public policy and related research, such as the identification of mining and contaminated "megsites".

In addition to these documents, the multi-year plan is revised to reflect advice that we receive from EPA's Science Advisory Board; the National Academy of Science; other researchers in the government, academic, and private sectors; and stakeholders who communicate with EPA in a variety of ways. Participation in research partnerships, technical conferences, and other professional activities also assists us in identifying the key part that ORD plays as the research arm of a regulatory agency with a proportionally small share of federal research dollars.

## **Background**

The assessment and cleanup of sites contaminated with hazardous substances, fuels, or oils are often complex processes, with both the variety and number of sites making cleanup costly and time-consuming. For Superfund, the National Priorities List (NPL) presently lists 1,232 sites and an estimated 40 new sites

will be added annually through at least 2010. There are more than 300,000 LUST CA sites, and states spend nearly \$2 billion annually to clean up these sites. Additionally, it is estimated there are potentially hundreds of thousands of old gas stations that may require remediation. Annually, 18,000 to 24,000 oil spills are reported and 10 million to 25 million gallons of oil are spilled, impacting coastal and inland waterways.

Contaminated sites under Superfund authority are addressed under provisions of the National Contingency Plan (NCP) (<http://www.epa.gov/superfund/contacts/ntlcplan.htm>) and related guidance documents (<http://www.epa.gov/superfund/action/guidance/index.htm>). Remedial actions follow a stepwise process from site discovery, through site assessment, through cleanup, to operation and maintenance and 5-year review. Removal actions are used when risks warrant near-term action.

Oil spills are also addressed under provisions of the National Contingency Plan, via a three-pronged approach of prevention, preparedness, and response (<http://www.epa.gov/oilspill/overview.htm>). Research addresses the latter two aspects of the program.

Corrective action for LUST sites is largely delegated to states and implemented by regulations with related guidance. In general, the process for leak response is to stop the release, report it, manage immediate risks, and then determine short- and long-term responses needed for cleanup.

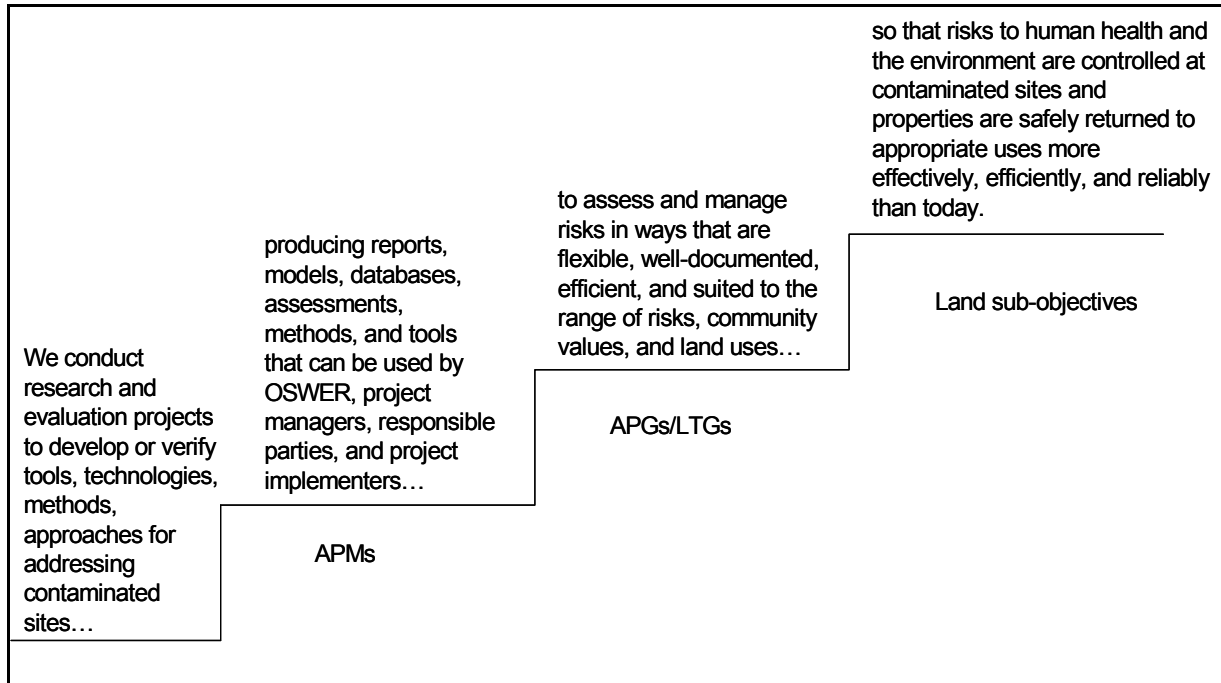
The ORD Contaminated Sites Research Program is designed, in collaboration with OSWER and Regions and with input from stakeholders, to address the most important science issues that affect policy development and program implementation. Because of limited resources, it is essential that our efforts are focused on the sites and problems that have higher risks, higher uncertainty, or higher impact in terms of number of sites, proximity to people, or value/size of ecological resources. We also focus on the sites types and problems where current approaches are most dollar- and time- intensive.

The Agency has identified strategic objectives and associated sub-objectives to achieve Goal 3—Preserve and Restore the Land.<sup>1</sup> Subobjective 3.1.2 cites a quantitative goal for responding to oil spills and a qualitative measure of response effectiveness. Subobjective 3.3.2 cites quantitative goals for cleaning up Superfund sites and releases from underground storage tanks. The research and science subobjectives are intended to enhance the scientific and technical foundation for achieving the programmatic objectives of Goal 3. Figure 1 shows the logic used to develop the research program needed to support achieving the strategic goal.

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<sup>1</sup> At the time this MYP was being updated, the Agency was revising its goal architecture and language. Appendix D contains the full draft of Goal 3 objectives and subobjectives as of 12/31/02, which are subject to change after the public comment period. Updates will be posted at <http://www.epa.gov/ocfo/>.

**Figure 1. Logic diagram for planning research to meet strategic needs of the Agency**



In addition to the broad needs implicit in the Agency's strategic plan, detailed research needs are provided by OSWER, EPA regions, and various stakeholder groups. Appendix D provides current needs lists developed by the Superfund and Oil Spills Programs.

There are a number of other agencies and groups with significant research programs that address contaminated sites. Of particular note are contaminated sites programs at the National Institute for Environmental Health and Sciences, the Agency for Toxic Substances and Disease Registry, and the Departments of Energy, Interior and Defense. ORD's contaminated sites research activities focus on research problems of highest priority to OSWER and the Regions, provide consultative support to these EPA offices, and provide an integrative perspective across a range of technical issues that is unavailable from these other groups. ORD coordinates closely with outside organizations to evaluate and utilize their findings, and to leverage our resources with theirs in collaborative research activities. Examples of collaboration and communication are shown in Table 1.



**Table 1. Examples of joint activities with other agencies, academia, and the private sector**

Topic	EPA's Partners
<b>Contaminated Sediments</b>	
Assessment	Sediment test methods (USGS); Technical advisory committee for National Sediment Inventory (USGS, NOAA); Technical advisory committee for the LA Harbor Contaminated Sediment Task Force (USGS, SCCWRP, NOAA, USACE, Environment Canada)
Remediation	Contaminated Aquatic Sediment Remedial Guidance Workgroup (USACE, NOAA, USFW, and States); Framework for Evaluation and Management of Contaminated Sediment Sites (USACE, NOAA, US Navy); RTDF Contaminated Sediments Action Team (USN, USACE, NOAA, academia, industry); ITRC Contaminated Sediments Team (states, USN, USACE, industry); South and Southwest Region Hazardous Substances Research Center (academia)
Workshops/ meetings	May 2003 workshop on sediment capping (USACE, academia, industry) June 2003 Workshop on Contaminated Sediments (USACE, American Chemistry Council)
<b>Ground water</b>	
General	Ground Water Forum (regions, states, DOE)
DNAPLs	Interagency DNAPL Consortium (DOE, NASA, USN, USAF); RTDF NAPL Cleanup Alliance (USN, state, private); Western Region Hazardous Substance Research Center (academia)
Remediation	RTDF Permeable Reactive Barriers Action Team (USAF, USACE, DOE, USGS, state, university); RTDF Bioremediation Consortium (DOD, DOE, industry); RTDF Phytoremediation of Organics Action Team (DOE, DOD, local/state government, 7 academic institutions)
Workshops/ meetings	2003 workshop on ground water research (NIEHS)
<b>Soil/Land</b>	
Remediation	RTDF Bioremediation Consortium (USAF, DOE, industry); Federal Facilities Forum (states, DOE); Western Region Hazardous Substances Research Center (academia, DOE, DOD)
Redevelopment	German Bilateral Agreement (German environmental ministry, states) ITRC Brownfields Action Team (states, private sector, DOE, academia)

## **Changes from Previous Version/Progress to Date**

### **Changes**

This version of the Contaminated Sites MYP includes a re-structuring of the long-term goals to focus on the issue being addressed, rather than on the risk paradigm or programmatic boundaries. Three of the long-term goals are media-based: contaminated sediments, ground water, and soil/land. An additional long-term goal includes activities that apply across media. Under each long-term goal, the related annual performance goals and measures are organized along themes that allow the reader to quickly focus on areas of interest, such as oil spills or DNAPLs. The new alignment of long-term goals and research themes also highlights how ORD laboratories and centers work on different facets of the same problem.

This version of the MYP also adopts the new goal architecture of the Agency's 2003 Draft Strategic Plan (see Appendix C). The trust funds that support Superfund, leaking underground storage tanks, and oil spills research are all in Goal 3. The Brownfields program, which is authorized to fund research as of 2002 but without research funding in the FY03 President's Budget, is in Goal 4. Brownfields research would be included in future editions of this plan if funds are appropriated.

Over the time period FY02-04, ORD has shifted considerable resources to increase research in contaminated sediments to meet program needs as controversial decisions are being made at large, complex sites around the country. Some resources were shifted within the Land Goal by reducing efforts on contaminated soils while other resources were shifted from other goals. Work that had been focused on remediation options has now been expanded to include characterization, monitoring, and risk assessment approaches that include the important bioaccumulation pathways affecting ecological and human receptors. Consequently, most of the research listed as unfunded needs in the December 2001 edition of the plan is now part of the base program. Several focus groups were formed to foster collaboration within ORD and with program and regional staff. Beginning in FY04, research funding is authorized for sediment remediation in the Great Lakes. If funding is authorized, linkages will need to be strengthened with Goal 2, Clean Water, to leverage research applicable to both Superfund sites and the Great Lakes.

Within the last two years, interest has been growing in assessing pathways that had not been fully evaluated in the past, namely migration of contaminants from ground water to surface water and migration of contaminants from the subsurface into residences via vapor intrusion. These pathways are also of concern for the RCRA program and relevant research is described in the RCRA MYP. Other drivers of increasing concern are: achieving more stringent cleanup standards as health or ecological effects research identifies risks at lower concentrations; performance of remedies over time; and the performance and cost of long-term remedies, such as pump & treat for contaminated ground water.

### **Research Progress**

Contaminated sediments research continued on risk management, with several field studies in progress to document remedy performance and assess tools applicable to characterization and monitoring. Good links have been established among ORD, OERR, and regions to collaborate in this research area and in developing guidance and products for project managers.

Research continued on groundwater issues. Permeable reactive barrier research is approaching a

milestone report describing medium-term performance at multiple field sites. With respect to leaking underground storage tanks, ORD has developed software for estimating biodegradation rates for fuel components from field data. This software was written so that it can be posted to the Internet, where ORD has a set of 30 other on-line calculators (<http://www.epa.gov/athens/onsite/>). These were developed for use in assessing contaminant impacts from LUST sites and are finding widespread usage in state LUST programs. Many of the ideas from the on-line calculators (i.e., calculation of gradients, retardation factors, plume diving, etc.) are planned for use in version 1 of the Tools for Analysis of Contaminated Sites (TACS) software to be submitted in FY04, and revised for FY06. ORD has also completed demonstrations of three commercial technologies for treatment of MTBE in groundwater. The results of the projects will be posted at <http://www.epa.gov/OUST/mtbe/mtbedemo.htm>.

Research on remediation of contaminated soils has declined in the past several years. A synthesis report on multiple studies of bioremediation was completed. Work continued on waste containment issues with focus on long-term performance of containment covers and cover design alternatives. Another major effort continued on landfill bioreactor research, supported under the RCRA MYP for new facilities and under this MYP for remediation of existing Superfund landfills. Dermal absorption modeling continued for contaminated soils; this work will also form the foundation for examining the dermal pathway for contaminated sediments. OSWER provided funds through the Brownfields program to begin activities on land redevelopment that will be applicable for the full range of contaminated sites, consistent with OSWER's One-Program initiative and emphasis on land reutilization.

In the area of sampling and analysis, progress has been made on a prototype sampler that will reduce contaminant losses from individual and composite samples. Combined with vacuum distillation, which is being pilot tested in Region 4, more accurate characterization of problematic volatile organic compounds will be significantly improved. The focus of PCB analysis was shifted to congener-specific quantitation of large-volume, lower-concentration samples, a need expressed by OERR. PCB immunoassay methods have been evaluated for analysis of samples from hazardous waste sites, and other environmental sampling sites. The feasibility assessment of an immunoaffinity probe for ion trap mass spectral determination of PCBs was completed.

Oil spills research continued to focus on protocols for spill control products and fate and transport modeling. Work was completed on a protocol to test the effectiveness of dispersants and studies continued on bioremediation.

## Overview of the Long-Term Goals

Contaminated Sites research is aligned in four long-term goals, with three of the goals based on the affected medium—sediment, ground water, and soil/land—and one goal for cross-cutting issues. Research in each LTG is organized by themes that identify particular problems encountered in addressing contaminated sites and returning them to a useful purpose. A small number of themes are also designed to allow easy tracking of trust funds and Congressionally-directed programs. This organization allows clients and stakeholders to quickly identify their areas of interest and facilitates ORD's cross-laboratory/center collaboration and resources management.

Research of interest to OERR and regional Superfund staff is incorporated in all four LTGs. LUST CA issues are dealt with in a single theme within the Ground Water LTG. Research for the Oil Spills program is in the multimedia LTG. Although there is a separate MYP for RCRA, much of the research in this plan is of interest to OSW and regional/state RCRA staff because they deal with similar issues at waste management facilities. Listings of research needs provided by stakeholders are presented in Appendix D.

### Contaminated Sediments LTG

Contaminated sediment sites include some large and controversial sites where risks are often disputed and costly remedies can take years to demonstrate results. The science for all aspects of the process--characterization, risk assessment, remediation, and performance evaluation--needs to be advanced simultaneously as EPA approaches decision points on sediment sites.

The contaminated sediments LTG contains three themes: addressing the controversial questions in characterizing sites and deriving more certain human and ecological risk assessments; addressing specific gaps in our understanding of specific human exposure pathways important at sediment sites; and expanding the number of remedial alternatives available with documented performance in managing risk at acceptable cost. Better approaches to community involvement and risk communication, are included in each theme because sediment sites can be "megasites" that involve multiple communities and strong but competing preferences of stakeholders.

### Long-Term Goals

- **Contaminated Sediments:** By 2010, improve the range and scientific foundation for contaminated sediment remedy selection options by improving risk characterization, site characterization and increasing understanding of different remedial options, in order to optimize the protectiveness to the environment and human health and the cost-effectiveness of remedial decisions
- **Ground Water:** By 2010, ORD will provide documented performance and cost information for at least 8 alternatives to pump and treat remedies and at least 6 tools for characterization and assessment that the Program Office can incorporate in guidance and that regions/states can apply in decision-making for sites in the clean-up programs
- **Soil/Land:** By 2010, 25 tools and methods will be provided that will allow the Agency to accurately and efficiently assess, remediate, and manage the soil and land in a healthy, productive, and sustainable state
- **Multimedia:** By 2010, provide 40 scientific tools, methods, and models, as well as technical support to (1) characterize the nature and extent of multimedia site contamination; (2) assess, predict, and communicate risks to human health and the environment; (3) evaluate innovative characterization and remediation options; and (4) develop testing protocols, risk management strategies, and identify fate and effects of oil spills

## **Ground Water LTG**

Contaminated ground water is a problem at most Superfund sites and at virtually all LUST corrective action sites. We now know that remedies are taking much longer than originally anticipated. Operation and maintenance costs are substantial and conventional remedies may not be able to achieve the cleanup objective in reasonable time or at all, particularly for contaminants that are newly found to pose risks at concentrations once deemed acceptable. Characterization of ground water contamination is also an issue, particularly for dense-non-aqueous phase liquids, which do not behave like dissolved contaminants, and for complex or lesser-investigated hydrologic settings and transport pathways.

The Ground Water LTG is divided into four themes to address issues that are common and for which solutions are not already available. DNAPL characterization and remediation are highlighted as a theme because the number of sites is large, contaminant distribution is variable, source controls are expensive, and residual concentrations often preclude achievement of cleanup goals. Fuel and fuel oxygenates are highlighted as a theme because the number of leaking storage tanks is large and fuel oxygenates are more-recently-recognized contaminants of concern that change fate and transport of fuel components and alter remedial effectiveness. Inorganic contaminants are highlighted because, despite their potential for health and ecological effects, most ground water research within ORD and the broader research community has been focused on organic contaminants. Surface treatment plants for inorganic contaminants have the same problems of high operation and maintenance costs as for organic contaminants and these costs will become more unacceptable as numerous mining sites in the Superfund pipeline approach the cleanup phase. The final theme in the ground water LTG covers complex hydrogeologic settings and under-evaluated contaminant transport pathways. Hydrogeochemistry research is generally advanced for porous media; models of contaminant fate and transport and existing remedies are most readily applied in such settings. Research is needed to ensure that the characterization and remediation methods can be extrapolated to these complex sites. Recently, there has been increasing evidence that contaminants in ground water can be transported to sediments, surface water, the vadose zone, and buildings. Research is included in this theme to make sure that site characterization, risk assessment, and remedial actions adequately account for these pathways.

## **Soil/Land LTG**

Contaminated soil is common at Superfund sites. Research has developed many cost-effective means to assess and ameliorate risks from contaminated soils. Although additional research is necessary to improve the science, ORD has reduced its investment in this research area over the last several years as research for contaminated sediment sites became more important for OSWER. Land management of contaminated materials and reutilization of contaminated sites remain important objectives for ORD.

The three themes in the soil/land LTG include research on sampling and analysis for inorganic and organic contaminants; contaminant exposure; and containment/remediation/land management. Analytical research is aimed at improving cost, accuracy, and speed for the most common or most difficult inorganic and organic contaminants. The narrow exposure theme is aimed at refining human exposure assessment for soil-borne contaminants. Research on risk management is focused mainly on landfills and containment approaches. The National Priorities List contains many old landfills that received mixtures of municipal and industrial wastes and many other site remedies include containment of non-principal-threat wastes. Management of risks at landfill and containment sites depends on the ongoing performance of the materials used to prevent contaminant transport. ORD is also investigating the application of landfill bioreactor retrofit technology to accelerate degradation of hazardous organic wastes in landfills as a

means to permanently lower risk.

Mining sites are a sizeable subset of Superfund sites with extensive land contamination and many difficulties associated with assessment and management. These sites are not a major theme in this LTG because ORD has a Congressionally-directed research program for remediation of mining sites. Additional research that could be done with additional resources is described in Appendix E.

There is no research funding for Brownfields included in the FY03 President's Budget. Under the new Small Business Liability Relief and Brownfields Revitalization Act of 2002, research is authorized and may be funded in future. Ongoing research that contributes to land reutilization is described in this LTG, along with specific products that are funded directly by OSWER's Brownfields Office through intra-agency funding transfer. No projections are made for research that might be funded in FY04 and beyond. Appendix E describes additional work that could be undertaken with additional resources.

## **Multimedia LTG**

The multimedia LTG contains five themes that address ongoing needs at contaminated sites. Two themes reflect the continuing need to advance exposure assessment and toxicity assessment for contaminants and pathways that are significant at Superfund sites. The work described in this plan is in addition to broader assessment work conducted under Goal 4. Accurate assessments are critical in determining which sites are to be cleaned up under Superfund and determining the degree of risk management required. Much of the information developed for Superfund is applicable to the other cleanup programs and to responsible redevelopment of Brownfields sites.

The oil spills theme covers research to support the preparedness and response functions of the Oil Spills Program within OERR, funded by a separate trust fund. Research is focused in three areas: developing a better understanding of fate and effects of spilled oil; development of testing protocols for spill control; and development of response options.

Technical support is an important multimedia theme. OSWER and the regions have consistently cited technical support, and particularly site-specific assistance, as their top priority for ORD. ORD has eight technical support centers that address these needs across the risk paradigm (see Appendix B).

The final theme in the multimedia LTG is the Superfund Innovative Technology Evaluation (SITE) Program. This Congressionally-mandated program is designed to accelerate acceptance of newly developed tools and technologies, largely arising from the private sector. The SITE program evaluates characterization, monitoring, and remediation approaches and produces reports that project managers use to gain confidence in selecting innovative tools and technologies for their sites. While the program directly supports Superfund, the results are applicable to RCRA, Brownfields, and voluntary cleanups.

## Resource Allocation Trends

Relative resource distribution among the long term goals is described in Table 2. A significant migration of resources from soils remediation research that began in FY01 was completed in FY03. Those resources were largely redirected to contaminated sediments.

**Table 2. Trends in Resource Allocations**

LTG/Theme	Trend
Contaminated Sediments Monitoring/measurement/modeling Remediation	increased FY01-03; level increased FY01-03; level
Ground Water DNAPL Inorganics Fuels from leaking USTs Complex hydrogeology/transport paths	level level level; Congressionally directed level
Soil/Land Inorganics Organics Exposure Land Management/Containment	decreased FY01-03; level decreasing for VOCs; level overall level decreased FY01-03; level
Multimedia Exposure assessment Toxicity assessment Oil Spills Technical Support SITE	level level level; Congressionally-directed level; co-funded by OSWER and ORD level; Congressionally-directed

## **Critical Path to the LTGs**

Annual performance measures and goals (APMs, APGs) describe the research program outputs that will result in achieving the long term goals. The terms APM and APG, from the Government Performance and Results Act, respectively indicate intermediate and final points along a work pathway leading to an LTG. This section of the MYP describes the critical paths, consisting of all APGs and selected APMs for Contaminated Sites research LTGs in both text and flow charts. A complete listing of all APMs is provided in table form in Appendix A of this MYP.

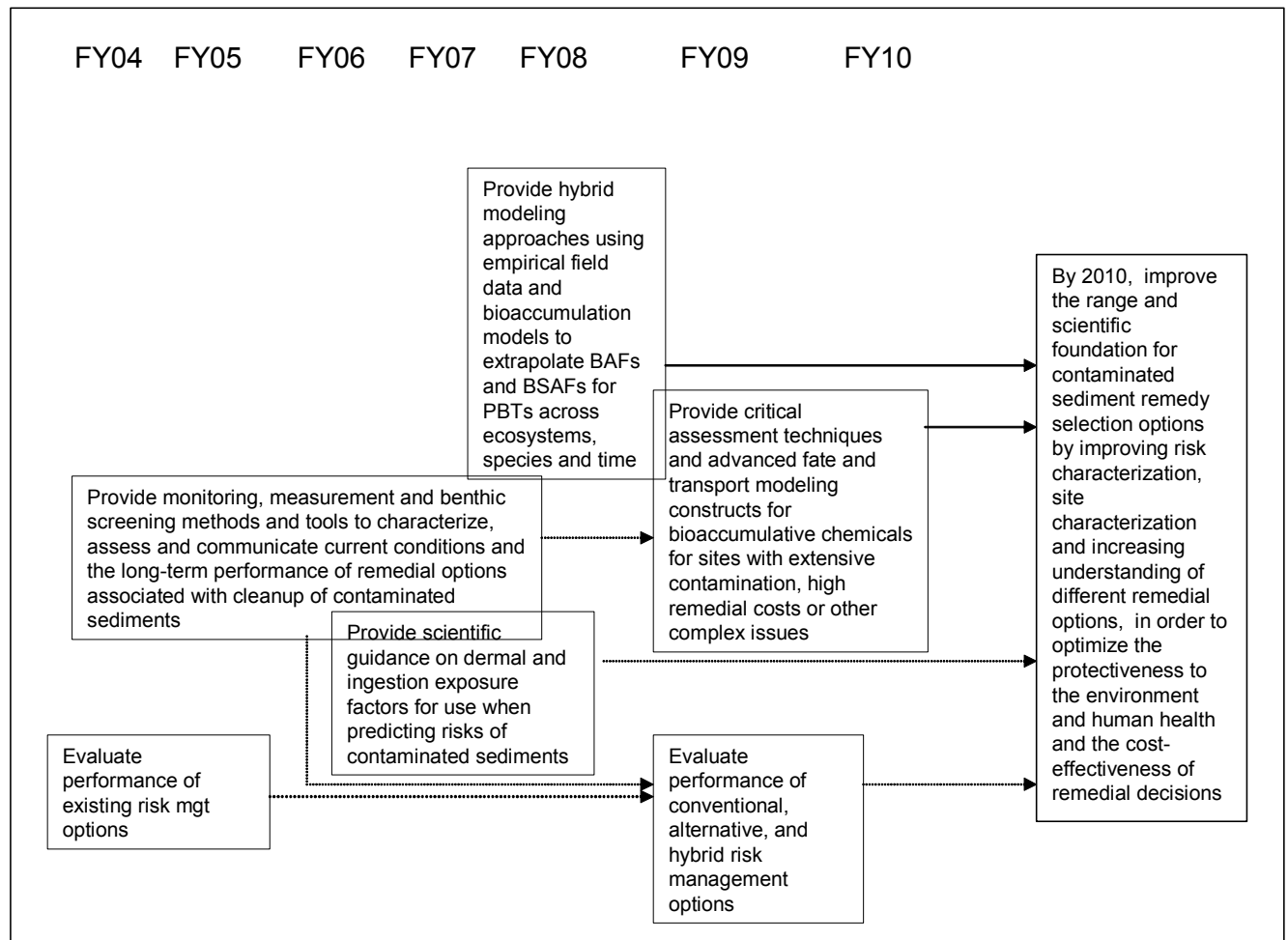
## **Contaminated Sediments LTG**

Approaches are currently available to assess and remediate contaminated sediment sites. These approaches, while serviceable, can be improved in several significant ways. The goal of ORD research in this area is to improve the range of options available, taking into account differences in size, complexity, and potential risk posed by different sites. Once achieved, the outcome of this effort will be greater scientific certainty that remedies selected are optimized for each site in terms of protectiveness to the environment and human health, and in terms of cost-effectiveness.

Achieving this contaminated sediments research goal requires a better understanding of some of the unique features of contaminated sediment sites. ORD will provide this better understanding through integration of findings from several highly targeted research themes, as shown in Flow Diagram 1. Risk characterization will be improved by providing guidance on dermal and ingestion exposure factors for humans (FY06). These tools will be refined in the context of knowledge gained from the site characterization research. Site and risk characterization will be improved by providing monitoring, measuring and benthic screening methods and tools (FY08), by providing hybrid modeling approaches using empirical field data and bioaccumulation models (FY08), and by providing critical assessment techniques and advanced fate and transport modeling constructs for bioaccumulative chemicals at sites with extensive contamination, high remedial costs or other complex issues (FY09). Improved remedy selection will result from an evaluation of performance of existing risk management options (FY04), leading to development and evaluation of performance of alternative and hybrid risk management options (FY09). The development and evaluation of risk management options will require perspectives gained from the site characterization research and the risk characterization research, and will provide data to test model performance.



## Flow Diagram 1 - Contaminated Sediment LTG



## Ground Water LTG

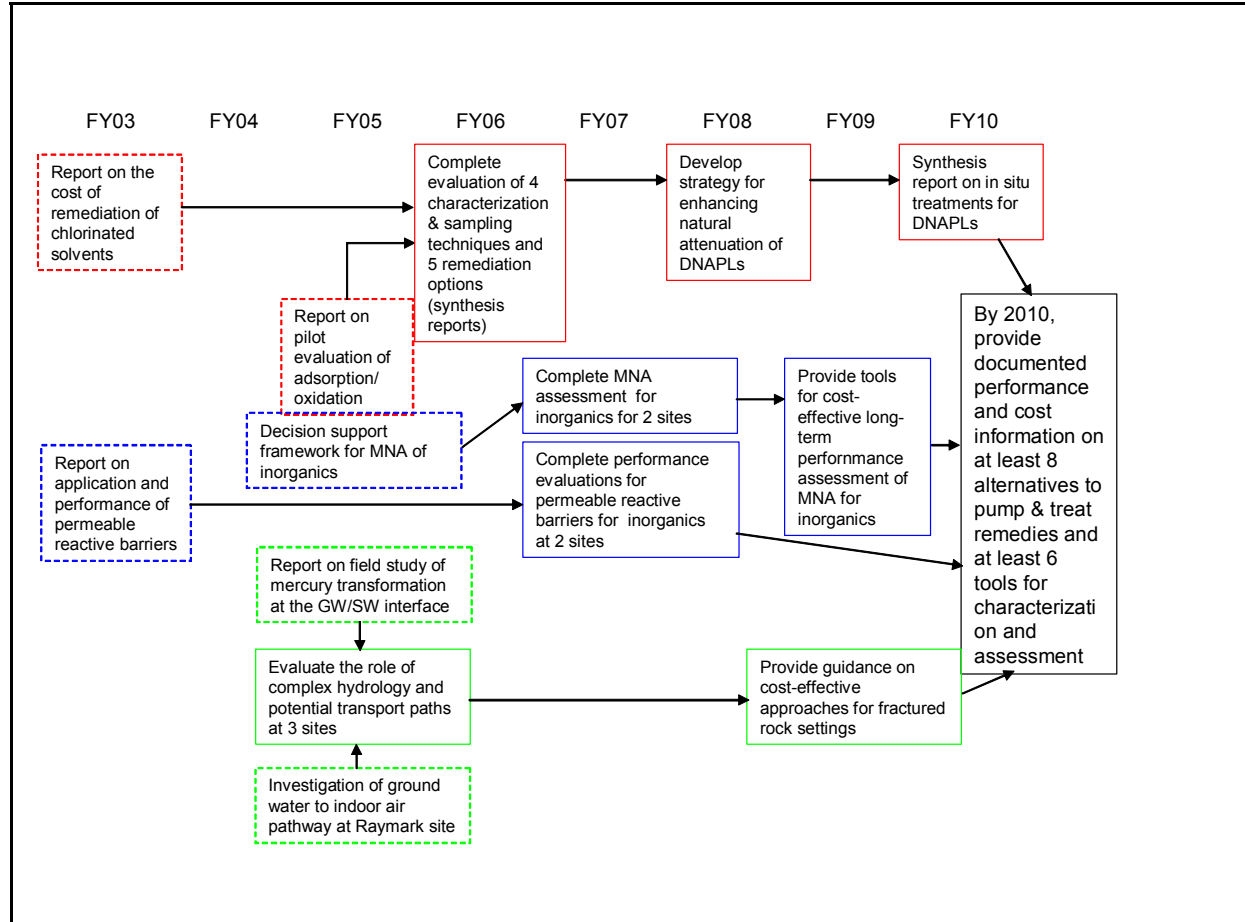
The ground water LTG is supported by 10 APGs that will advance our ability to address DNAPLs, inorganics, and fuel contamination, as well as extend characterization and remediation technologies to complex settings and underevaluated transport pathways.

APGs in FY06, FY08, and FY10 describe the critical path for **DNAPL** research (Flow Diagram 2). Ongoing work will culminate in synthesis reports on geophysical characterization and alternative remediation approaches in FY06. Research on enhancing natural attenuation will continue through FY08 and a synthesis report on the next generation of remediation technologies will be completed in FY10. The specific work undertaken to support the latter two APGs will be informed by an expert panel's report expected in FY03. The panel was asked to address the effectiveness of source elimination and the options for dealing with inevitable residual contamination. A substantial investment of SITE resources for innovative remediation technologies contributes to the FY06 APG.

Remediation of **inorganics plumes** (Flow Diagram 2) in ground water follows a dual track of assessing the potential effectiveness of monitored natural attenuation (MNA) and permeable reactive barriers. Because metals can't be destroyed, the mechanisms of immobilization are critical to the long-term performance of these approaches. APGs in FY07 and FY09 address research on MNA. This research area focuses on identifying the attenuation mechanisms and the anticipated stability of the immobilized metals under anticipated geochemical conditions. Research on permeable reactive barriers (PRBs) has an intermediate FY07 APG that provides two cases of PRB performance in the near-term. Additional research, beyond the time horizon of this plan, will be needed to evaluate the long-term performance and efficiency of PRBs and extend the range of metals that can be addressed with this technology.

**Under-evaluated pathways and complex hydrogeology** (Flow Diagram 2) impede the evaluation and remediation of contaminants at some sites. Initial efforts on underevaluated pathways culminates in an FY05 APG that should determine effective ways of assessing contaminant discharge from ground water to sediments and surface water and contaminant migration from ground water and the vadose zone to indoor air. Further research in these areas will be developed in a subsequent revision of this plan as the extent of the problems become more defined through this research and research conducted by others. Research on characterization and remediation in fractured bedrock is represented by two APGs that describe an initial case study and a subsequent synthesis of effective options for these sites.

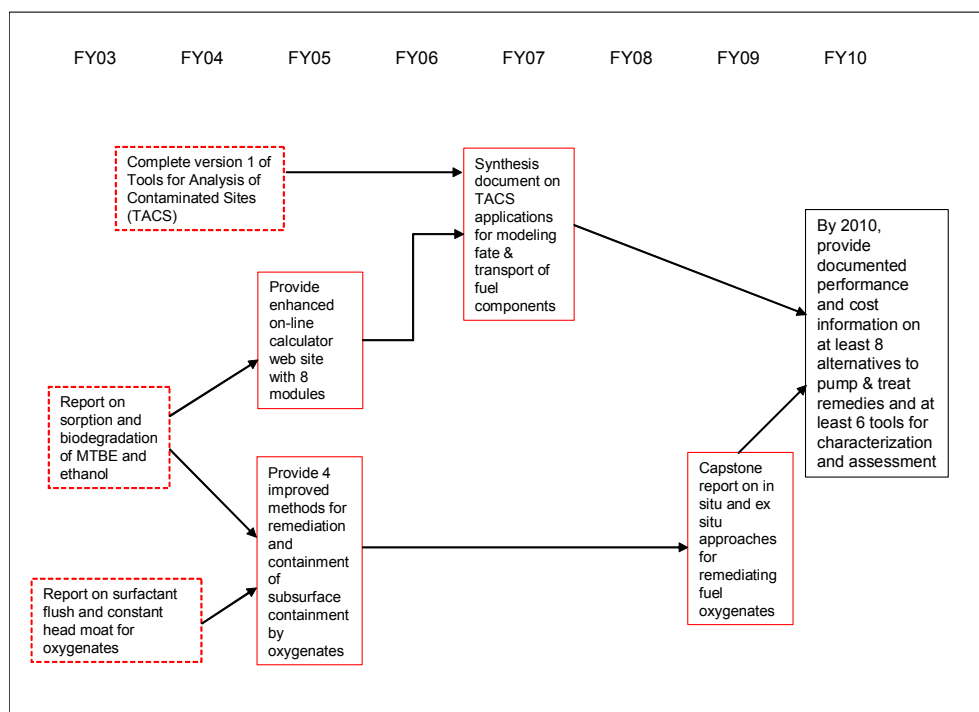
**Flow Diagram 2 - Ground Water–DNAPLs, Inorganics, Hydrology**  
 Selected APMs are shown in dashed boxes.



Research on **Fuel Releases** (Flow Diagram 3) from leaking underground storage tanks (LUST) has shifted focus to include oxygenates that represent a characterization and remediation challenge in themselves, as well as affecting the behavior and treatment of hydrocarbon fuel components. Fate and transport studies lead to improved modeling capability that predicts plume behavior and the effectiveness of remedial alternatives. APGs in FY05 and FY07 describe the development of a set of on-line calculators and a modeling system intended to be used by states in assessing the large number of LUST sites. Remediation research through the FY05 APG addresses multiple remediation approaches applicable to spilled fuels, with and without the oxygenates MTBE and ethanol. These approaches include in-situ and ex-situ treatments, and containment methods that could be applied to existing spills or engineering as a safety feature of new storage tank placements. Lab and field studies from remediation research are used in fate and transport research to identify or verify plume behavior and natural degradation. Remediation research beyond the FY05 APG will include other oxygenates for use in fuels and assessment of how well they can be managed with methods developed for MTBE.

### Flow Diagram 3 - Ground Water LTG–LUST

Selected APMs are shown in dashed boxes



## Soil/Land LTG

The soil/land LTG is organized in two themes that will provide the Agency with tools and methods for the accurate and efficient assessment of contaminated sites and provide options for remediation, containment, and site reutilization that are protective of human health and the environment (Flow Diagram 4).

The assessment theme comprises analytical methods development to ensure accurate determination of contaminant concentrations and exposure methods development to account for the dermal pathway.

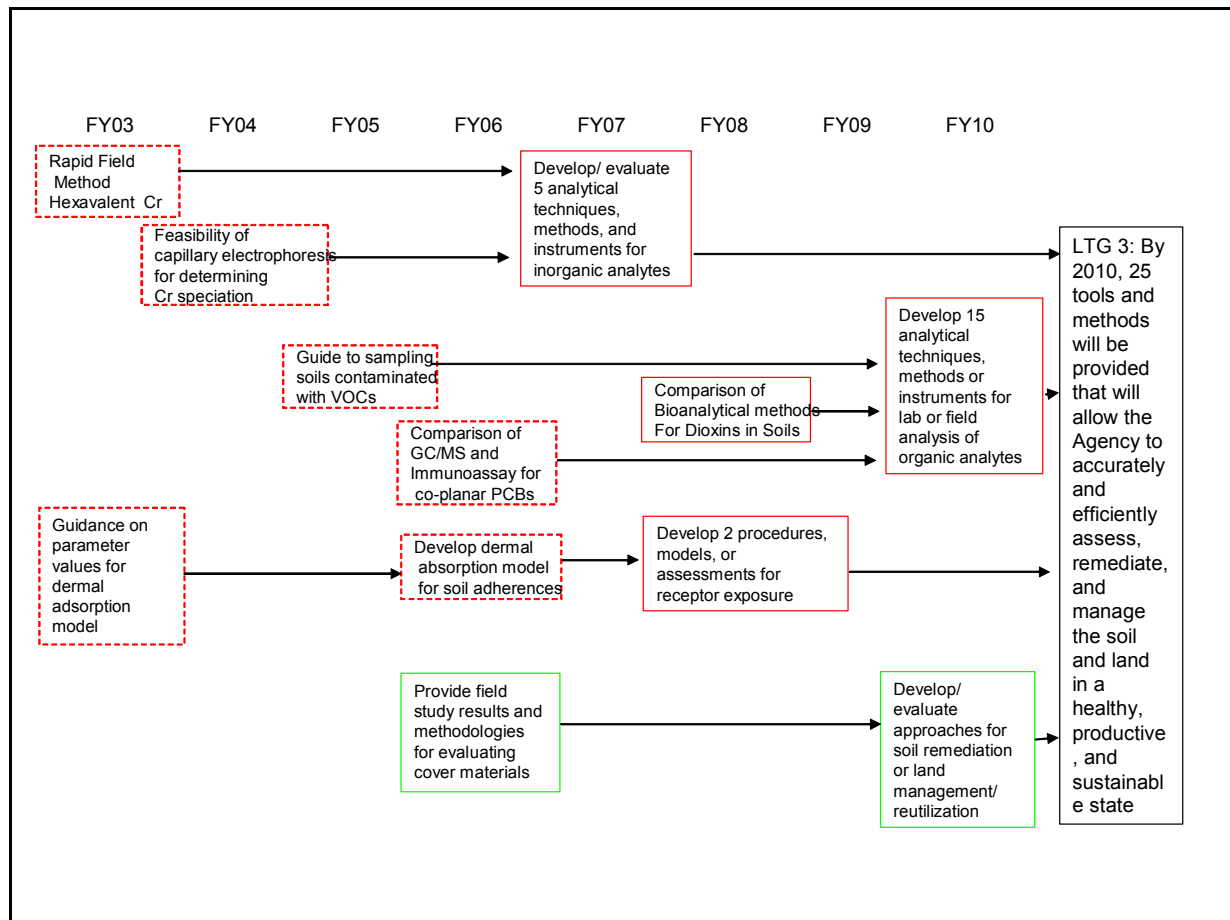
**Analytical methods** research is represented by APGs in FY07 and FY10 that represent advances for inorganic species and organic compounds, respectively. The focus of inorganic analytical development is on mercury and chromium, which are common contaminants that exist in multiple states that influence both fate and transport and remediation options. Emphasis is on development of rapid, field-deployable methods, speciation methods, and lower detection limits/better identification techniques. Research on organic compound analyses is focused in the earlier years on completing VOC work aimed at accurate collection and quantification of common contaminants highly susceptible to losses that can underestimate risks. Research on methods for persistent, bioaccumulative, and toxic compounds (PBTs) continues throughout the range of this plan. Two major targets are PCBs and dioxin, largely determined by their presence at many sites, their toxicity at low concentrations, and toxicity variations among congeners. Individual APMs represent analytical improvements for other compounds of concern and are expected to change more in subsequent revisions of this plan as the fields of analytical chemistry and toxicity advance.

The need to better assess the potential harmful effects of soil-borne contaminants on human health is reflected in the FY08 APG. The **dermal exposure pathway** research is focused on producing guidance on parameters used in the dermal adsorption model and various factors that relate to the evaluation of the risk associated with the dermal route of exposure. In FY06, the dermal absorption model will be modified to incorporate the effect of soil adhesion on contaminant uptake. The research on dermal exposures from soil will be used as the foundation for analogous research for contaminated sediments.

Containment/Remediation/Reutilization - The objective of this research is to assess the long-term integrity, technical performance, cost-effectiveness, and predictability of containment system performance with an emphasis on containment cover systems at landfills. Alternative cover designs and long-term containment system performance are, along with characterizing emissions from landfills (funded directly by OERR), the highest priority containment issues for OSWER. Ongoing studies of geosynthetic cover materials and alternative, plant-based covers will complete evaluation and performance assessments by FY06. Subsequent studies of longer-term performance and refinements will continue through FY10, likely including second generation evapotranspiration covers and third generation engineered covers as technology advances in the overall research community. Evaluation of unintended cross-media transfer, via gas emissions or vapor intrusion, is included in the FY10 APG. Landfill bioreactor research, largely addressed in the RCRA MYP, is relevant to Superfund landfills, as a retrofit application designed to permanently reduce risks.

## Flow Diagram 4 - Soil/Land

Selected APMs are shown in dashed boxes.



## Multimedia LTG

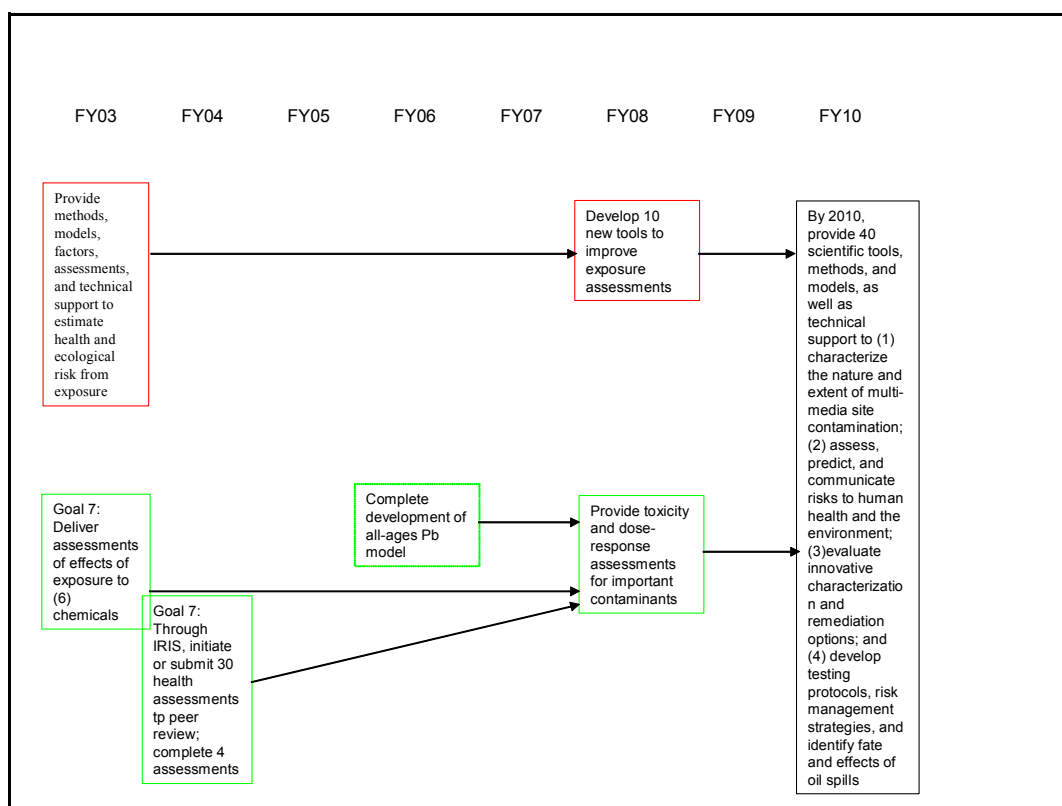
Flow Diagram 5 describes the **exposure assessment and toxicity assessment** themes of the multimedia LTG. The multimedia long term goal is constructed to model the major elements of the Superfund risk assessment paradigm -- data collection, exposure assessment, and toxicity assessment. Data collection research focuses mainly on developing better field analytical methods and statistical protocols that provide site investigators with better definition with the extent of contamination.

Exposure assessment takes the available site and contamination data that was collected and combines it with information on the exposure factors of the local populations to formulate an estimate of human exposure. The FY03 APG provides additional data and methods for use by risk assessors in the near term. The APMs include improving the database for food consumption and dietary fat consumption and updating the non-cancer health effects of PCBs for inclusion in IRIS. The outyear APGs focus on exploring new tools for exposure assessment and reducing the uncertainty in the concentration of contaminants present in contaminated media. The FY05 APG provides an assessment of applying

probabilistic tools for risk assessment. The FY08 APG includes analytical chemistry and statistics. Analytical chemistry research will provide improved analysis for metals, PCBs, SVOCs, and tentatively-identified compounds (TICs), all common at contaminated sites. The statistics research reflects continued development of SCOUT software to assess the validity of analytical data used in both risk assessment and evaluation of remedial alternatives. Additional exposure assessment research undertaken for media-specific problems is reflected in other LTGs

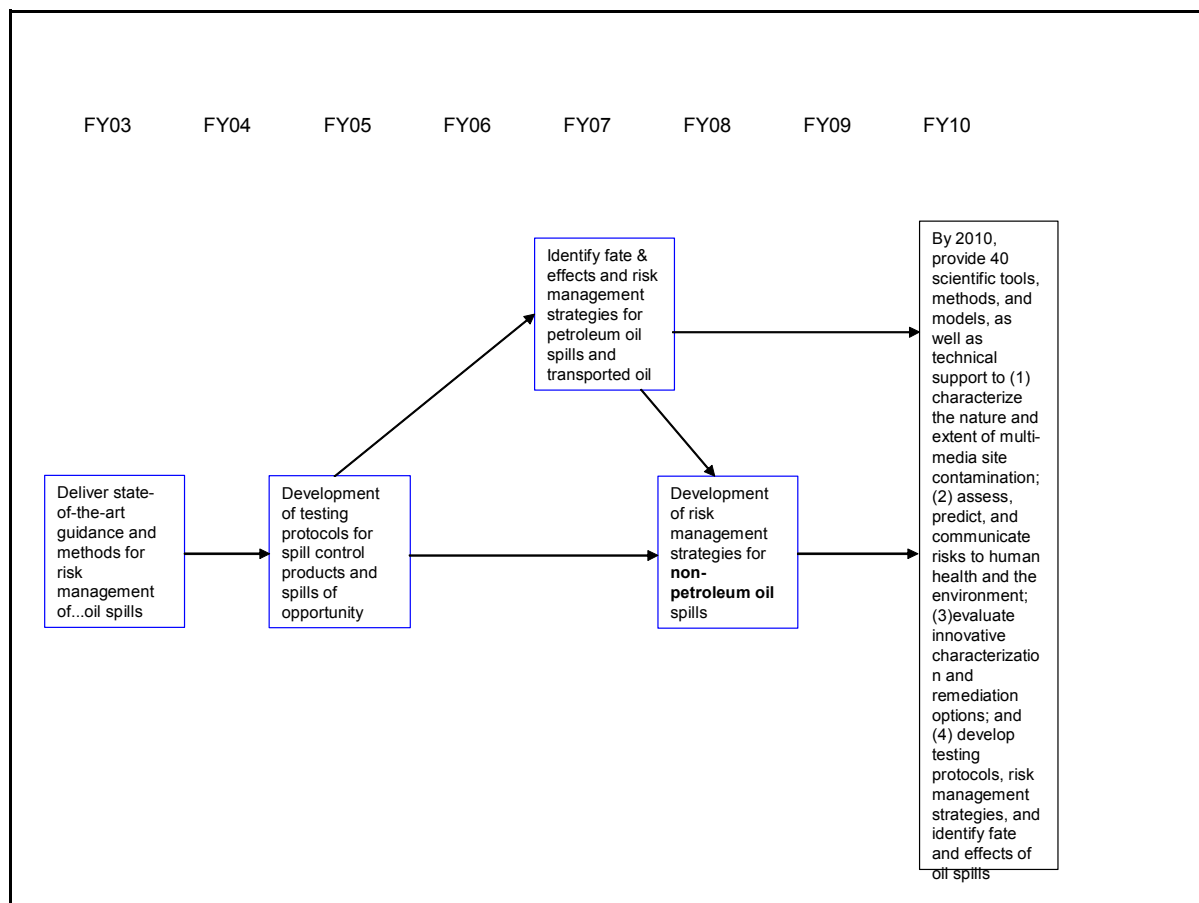
Toxicity assessments provide risk assessors with estimates of the toxicologic properties of the contaminants that have been detected at the site. Most toxicity assessments for Superfund rely upon chemical assessment conducted under EPA's IRIS program (Goal 4). In addition to IRIS assessments, research incorporated in the Contaminated Sites MYP focuses on contaminants of particular interest to Superfund. The FY08 APG will provide improved dose-response assessments for lead, dioxin, and mixtures. A series of four APMs describes the critical path to completing the all-ages lead (AAL) model that has been under development for several years as a successor to the IEUBK.

### Flow Diagram 5 - Multimedia LTG – Exposure and Toxicity Assessment



Flow Diagram 6 describes the **oil spill** theme. ORD research addresses the Agency's preparedness and response responsibilities with respect to risk assessment and site remediation. The APGs encompass development of protocols to evaluate risk management options, development of risk management strategies for petroleum and non-petroleum oil spills in fresh and saline environments, and evaluation of the fate and effects of oil spills. By FY05 a series of protocols will be developed to determine the effectiveness of bioremediation products, dispersants, surface washing agents, and other products. By FY07, laboratory and field studies will be completed on the risk management and fate and effects of oil in fresh and saline environments. This will include work on petroleum and fuel emulsions, chemical and biological treatment, climatic effects on oil spills, dispersant modeling, and ecosystem exposure as a function of various response scenarios. By FY08, risk management strategies will be developed for non-petroleum oil spills. This will include laboratory and field studies in freshwater and saline environments at mesophilic and cold temperatures. Leverage is being sought with the Canadian government whose research goals and objectives are similar to those of ORD.

### Flow Diagram 6 - Multimedia LTG – Oil Spills





**Technical support** for Superfund is included in the multimedia LTG. Technical support is consistently rated by the program office and the regions as the top priority for ORD. A stable, consistently-funded technical support program has been developed over the years, comprising technical support centers, ORD staff located in the regions, and access to ORD staff for program support. The main focus of the program is site-specific assistance to regional project managers (Remedial Project Managers and On-Scene Coordinators). Other aspects of the program include technology transfer via hotlines, websites, workshops, client-oriented publications, etc. In addition to ORD resources of FTE and extramural funds, OSWER and Regions provide Superfund extramural funds directly to several of the centers. More than 500 assistance activities are completed for more than 100 sites in most years. Technical support activities do not lend themselves to presentation in a flow chart. Table A-1 describes the APMs and APGs for technical support, which are focused on documenting the activities, results, and trends. Technical support is further described in Appendix C.

The **SITE program** is the component of the multimedia LTG that facilitates the application of commercial-scale or nearly commercial-scale characterization and remediation approaches to actual contaminated sites. This Congressionally-directed program provides an independent assessment and documentation of the performance and cost of emerging commercial technologies. APGs and APMs for the SITE program, shown in Table A-4, are based on the annual requirement for a report to Congress and a commitment to completing a fixed number of demonstrations over three-year time intervals. The APGs are intended to convey the notion that demonstrations over a given time period focus on technologies where ORD, the program office, regions, and “problem owners” have identified a shortage of satisfactory options. Thus, the FY05 APG specifically notes the current focus on contaminated sediments and DNAPLs. The subsequent APG will be honed in future revisions of the plan to reflect new characterization and remediation issues that come to the forefront. The reports to Congress document the impact that the SITE program has made, in terms of accelerating technology application and documenting improvements in cost or performance that new technologies represent. More information on the SITE Program can be found at <http://www.epa.gov/ORD/SITE>.

## Appendix A - Annual Performance Goals and Measures

The following four tables list planned APGs and APMs for the period covered in the multi-year plan. Except as indicated, these are not official GPRA commitments. Because the long-term goals were restructured for this version of the plan, existing FY03 and FY04 official APMs are shown in the table with the appropriate out-year APG, even if they are linked in GPRA to an APG that fit the old LTG structure. The last column in each table designates the APG or APM as internal (i) or external (e) for GPRA reporting purposes. An external designation is only made for the planning year (current FY+2).

**Table A-1. Long-term Goal 1–Contaminated Sediments**

<b>Long-Term Goal 1:</b> By 2010, improve the range and scientific foundation for contaminated sediment remedy selection options by improving risk characterization, site characterization and increasing understanding of different remedial options, in order to optimize the protectiveness to the environment and human health and the cost-effectiveness of remedial decisions				
<b>By 2004 Provide risk assessors and managers with site-specific data sets on three applications detailing the performance of conventional remedies for contaminated sediments to help determine the most effective techniques (APG 04-5)</b>		<b>FY04</b>	<b>NRMRL</b>	i
	Journal article on natural recovery of PCB-contaminated sediments at Lake Hartwell (APM 03-259)	FY03	NRMRL Dick Brenner	i
	Technical resource document on monitored natural recovery of contaminated sediments (APM 04-74)	FY04	NRMRL Dennis Timberlake	i
	Reports on performance data for conventional sediment remedies for three sites (APG 04-75)	FY04	NRMRL Dennis Timberlake	i
<b>By 2006 provide scientific guidance on dermal and ingestion exposure factors for use when predicting risks of contaminated sediment</b>		<b>FY06</b>	<b>NCEA</b>	i
dermal	Publish review of factors used to characterize dermal contact with sediment - might have to be scaled back owing to FY03 reduction	FY04	NCEA John Schaum	i
	Report on how to characterize dermal absorption and/or exposure from sediment-borne chemicals (draft submitted for publication)	FY06	NCEA John Schaum	i
	Submit for publication one or more studies to characterize dermal absorption or exposure from chemicals in sediments	FY06	NCEA John Schaum	i
fish ingestion	Report on estimating fish intake levels for various human subpopulations, including anglers and subsistence populations (external peer review draft)	FY06	NCEA Jackie Moya	i

<b>By 2008 provide monitoring, measurement and benthic screening methods and tools to characterize, assess, and communicate current conditions and the long-term performance of remedial options associated with cleanup of contaminated sediments</b> (new wording for APG08-174)		FY08	NHEERL	i
	Provide a Sediment Toxicity Identification Evaluation (TIE) Manual	FY03	NHEERL Kay Ho	i
	Manuscript describing identification of ionic toxicity in sediments from the Calcasieu River Superfund site.	FY04	NHEERL Kay Ho	i
	Report on the use of small short lived fish as indicators of pre and post remediation of persistent bioaccumulative toxics	FY04	NERL Jim Lazorchak	i
	Provide an approach to long-term ecological monitoring to assess the effectiveness of contaminated sediment remediation at the New Bedford Harbor, MA Superfund site (APM 04-5)	FY04	NHEERL Skip Nelson	i
	Provide procedures for deriving Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms from <ul style="list-style-type: none"> <li>• Metal Mixtures;</li> <li>• PAH Mixtures;</li> <li>• selected other organic compounds</li> </ul>	FY04	NHEERL Rob Burgess	i
	Report on chemical extraction and sorption of arsenic in sediments	FY04	NRMRL Chris Impellitteri	i
	Report on the potential of phytoremediation to remediate contaminated sediments (APM 04-330)	FY04	NCER Mitch Lasat	i
	Use of semi-permeable membranes as a surrogate in assessing bioaccumulation	FY05	NRMRL Joe Schubauer-Berigan	i
	Report on results of pre- and post-remediation toxicity assessments, bioassessments (periphyton, macroinvertebrates and fish monitoring), and toxicogenomic assessments.	FY05	NERL Jim Lazorchak	i
	Stimulate scientific research on environmental risk communication and community involvement to empower communities to participate more effectively in decision-making at contaminated sediment sites	FY05	NCEA Kevin Garrahan	i
	Develop and evaluate "reactive" caps to contain and treat contaminated sediments in-situ	FY05	NCER Mitch Lasat	i
	Report of tests of electrochemical degradation as a reactive barrier	FY05	NRMRL Souhail Al-Abed	i

	Collection of undisturbed surface sediments for the determination of contaminant distributions (journal and fact sheet)	FY05	NERL Brian Schumacher	i
	Report on innovative techniques for measuring advective flux	FY06	NRMRL Bob Lien	i
	Impact of metals speciation on ecological receptors	FY06	NRMRL Kurt Schekel	i
	Development of sensitive, reliable, and cost-effective elemental speciation methods to measure the toxic and mobile forms of inorganic contaminants (e.g., As, Se, Sn, Hg, etc.) in sediments	FY06	NERL Georges-Marie Momplaisir, Charlita Rosal	i
	Provide experimental techniques and conceptual models capable of predicting contaminated sediment transport and contaminant bioavailability during resuspension events caused by storms, bioturbation and dredging	FY06	NHEERL Rob Burgess	i
	Determination of the influence of newly deposited sediments on contaminant concentrations in collected samples (journal and fact sheet)	FY06	NERL Brian Schumacher	i
	Report on MNR performance at Lake Hartwell at the modeled compliance time	FY06	NRMRL Dick Brenner	i
	Draft journal article and/or practitioner's guide on how to best use public issue forums to empower communities to participate more effectively in contaminated sediment cleanups	FY06	NCEA Kevin Garrahan	i
	Develop performance metrics that can be applied to measure community preferences for site cleanups and the effectiveness of community involvement processes	FY07	NCEA Kevin Garrahan	i
<b>By 2008 provide hybrid modeling approaches using empirical field data and bioaccumulation models to extrapolate BAFs and BSAFs for PBTs across ecosystems, species and time</b>		<b>FY08</b>	<b>NHEERL</b>	<b>i</b>
	Provide a hybrid modeling/empirical approach for predicting BAFs, BSAFs, and resulting risks from metabolized chemicals such as dioxins and PAHs (revised wording for APM 04-6)	FY04	NHEERL Lawrence Burkhard	i
	Provide an evaluation and recommendations on methods and models to assess bioavailability, bioaccumulation, and ecological effects of bioaccumulative organic chemicals in sediments.	FY06	NHEERL Lawrence Burkhard	i
	Provide a fully field validated hybrid modeling/empirical approach for extrapolating BAFs, BSAFs, and predicting the ecological effects of mixtures of PBTs with differing rates of metabolism on a site-specific basis.	FY08	NHEERL Lawrence Burkhard	i

<b>By 2009 provide critical assessment techniques and advanced fate and transport modeling constructs for bioaccumulative chemicals for sites with extensive contamination, high remedial costs, or other complex issues</b>		<b>FY09</b>	<b>NERL</b>	i
	Report on the evaluation of existing contaminated sediment mass fate and transport models and bioaccumulation models.	FY03	NERL Earl Hayter	i
	Develop improved models to characterize bioavailability of organic contaminants in sediments (APM 04-326)	FY04	NCER Mitch Lasat	i
	Assessing significance of volatilization of PCBs from lake surfaces	FY04	NRML Paul dePercin	i
	Develop and validate models to predict toxic metal release during dredging and resuspension.	FY05	NCER Mitch Lasat	i
	Report on the effect of organic matter on bioavailability, and toxicity of As and Se in sediments.	FY05	NCER Mitch Lasat	i
	Development of new modules for selected fate and transport model(s) for certain types of water bodies to address the identified sediment-related needs of OERR and the Regions.	FY05	NERL Earl Hayter	i
	Report on the evaluation of long-term (i.e., 1 - 10 years) accuracy of the upgraded contaminated sediment fate and transport models by modeling the transport and fate of sediments in a demonstration site.	FY05	NERL Earl Hayter	i
	Provide consensus framework for modeling remedial alternatives in large water bodies and estuaries.	FY07	NERL Earl Hayter	i
<b>By 2009, provide performance data on conventional, alternative, and hybrid risk management options</b>		<b>FY09</b>	<b>NRML</b>	i
	Journal article on innovative technology for contaminated sediment remediation - Minergy demo (APM 03-260 linked to APG 03-11)	FY03	NRML Marta Richards	i
	Complete SITE demonstration report on sediment capping or treatment technology (APG04-78)	FY04	NRML Marta Richards	i
	State-of-the-practice document for PCB treatment in saline environments	FY05	NRML Tom Holdsworth	i
	Biostimulation for remediation of PCBs in sediments	FY05	NRML Tom Holdsworth	i
	Report on trials of in-situ treatment cap	FY06	NRML Vince Gallardo	i

	Interim report on biodegradation of PAHs in sediments	FY07	NRMRL Dick Brenner Carolyn Acheson	i
	Laboratory evaluation of metal biostabilization	FY07	NRMRL Wendy Davis- Hoover	i
	Impact of available carbon on metal speciation	FY07	NRMRL Kurt Schekel	i
	Pilot-scale evaluation of stabilization of metals in sediments	FY07	NRMRL Kurt Schekel	i
	Evaluation of perturbation on metal speciation and ecological receptors	FY08	NRMRL Kurt Schekel	i
	Report of field evaluations of electrochemical treatment in a metal/organic environment	FY07	NRMRL Souhail Al- Abed	i
	Report on medium-term performance of emplaced caps relative to predictions	FY07	NRMRL Terry Lyons	i
	Report on performance of physical/chemical treatment process	FY07	NRMRL	i
	Report on experience with innovative biological treatment process	FY08	NRMRL	i
	Capstone report on treatment of PCBs in sediments	FY08	NRMRL Dennis Timberlake	i
	Final report on biodegradation of PAHs in sediments	FY08	NRMRL Dick Brenner Carolyn Acheson	i
	Capstone report on treatment of PAHs in sediments	FY09	NRMRL Dick Brenner Vince Gallardo	i

**Table A-2. Long-term Goal 2–Ground Water**

<b>Long-term goal 2:</b> By 2010, ORD will provide documented performance and cost information for at least 8 alternatives to pump and treat remedies and at least 6 tools for characterization and assessment that the Program Office can incorporate in guidance and that regions/states can apply in decision-making for sites in the clean-up programs				
<b>DNAPLs</b>				
<b>By FY06, evaluate at least 4 characterization and sampling tools and at least 5 remediation options for DNAPLs</b>		<b>FY06</b>	<b>NERL</b>	i
char- acter- ization	Reports on the results of the capabilities of non-intrusive borehole dielectric techniques for detection of non-aqueous phase liquids (NAPLs) above and below ground water at contaminated waste sites (journal article) (APM 04-319)	FY04	NERL Aldo Mazzella	i
	Interpretation of complex geologic structures via ground penetrating radar to allow for the non-intrusive mapping of spilled NAPLs. (model, fact sheet and journal article) (APG 04-212)	FY04	NERL Aldo Mazzella	i
	Evaluation of the performance of new and innovative samplers for DNAPL-contaminated ground water monitoring to identify the best ground water samplers and verify their performance under real world conditions, thereby providing OERR/Regions with information to select the best technique(s) available. (journal article and fact sheet)	FY05	NERL Steve Gardner	i
	Develop and evaluate models to predict contaminant sequestration in micropores of aquifer sediments	FY05	NCER Mitch Lasat	i
	Delineation via complex resistivity of the movement of perchloroethylene through soil to provide OERR/Regions with another tool to assess the extent and distribution of DNAPLs in the subsurface using non-intrusive technology. (journal article and fact sheet)	FY05	NERL Aldo Mazzella	i
	Use of geophysical techniques to monitor perchloroethylene remediation to provide OERR/Regions with another tool(s) to assess the extent and distribution of DNAPLs in the subsurface using non-intrusive technology. (journal article and fact sheet)	FY06	NERL Aldo Mazzella	i
remedi- ation	Report on the cost of remediation for sites contaminated with chlorinated solvents	FY03	NRMRL Dennis Miller	i
	Report on solvent-enhanced residual biotreatment of residual DNAPL	FY04	NRMRL Susan Mravik	i
	4 SITE demonstration reports on evaluation of innovative DNAPL remediation processes.	FY03	NRMRL Annette Gatchett	i

	Develop and evaluate microbial populations for effective TCE biodegradation (APM 04-328 linked to APG 06-173)	FY04	NCER Mitch Lasat	i
	Optimization of Pd-catalyzed remediation of groundwater contaminated with aliphatic chlorinated solvents (APM 04-329 linked to APG 06-173)	FY04	NCER Mitch Lasat	i
	Report on residual biotreatment for thermal remediation methods	FY05	NRMRL Marta Richards	i
	Report on pilot scale evaluation of adsorption/oxidation technology for ground water remediation.	FY05	NRMRL Scott Huling	i
	Develop and evaluate cost-effective methods for nutrient mixing and delivery for bioremediation of chlorinated aliphatic hydrocarbons	FY05	NCER Mitch Lasat	i
	Synthesis report on 5 DNAPL remediation technologies	FY06	NRMRL Bob Puls, Annette Gatchett	i
	Synthesis report on characterization tools for DNAPL sites	FY06	NERL Aldo Mazzella	i
<b>By FY08, develop strategy for enhancing natural attenuation of DNAPLs</b>		<b>FY08</b>	<b>NRMRL</b>	<b>i</b>
	Evaluation of a bioassay for biologically- available iron (III) in aquifer sediment	FY04	NRMRL John Wilson	i
	Evaluation of microbial communities responsible for natural attenuation of DNAPL compounds in ground water.	FY05	NRMRL John Wilson	i
	Identification of, and characterization methods for, reactive minerals responsible for natural attenuation of DNAPL compounds in ground water.	FY07	NRMRL Bob Puls	i
	Report on methods to enhance natural attenuation of DNAPL plumes using both biotic and abiotic approaches	FY08	NRMRL Bob Puls	i
<b>By FY10 produce a synthesis report on innovative in situ remedies for DNAPL sites</b>		<b>FY10</b>	<b>NRMRL</b>	<b>i</b>
	Report on long term impacts of source treatment of DNAPLs	FY07	NRMRL Lynn Wood	i
	Report on processes impacting thermal remediation effectiveness	FY07	NRMRL Eva Davis	i
	Methods for screening for polar contaminants in ground water using HPLC/DAD and identifying them using GC/MS with derivatization (journal article and fact sheet).	FY08	NERL Bill Brumley	i



	Synthesis document on DNAPL remediation technologies	FY10	NRMRL Bob Puls, Annette Gatchett	i
<b><i>Inorganic contaminants</i></b>				
<b>By FY07 complete MNA assessments for inorganics for at least 2 sites</b>		<b>FY07</b>	<b>NRMRL</b>	<b>i</b>
	Report on assessment of the natural attenuation of arsenic in an urban industrialized watershed.	FY04	NRMRL Robert Ford	i
	Report on assessment of the natural attenuation of (other inorganic contaminant).	FY07	NRMRL Bob Puls	i
<b>By FY07 complete performance evaluations of permeable reactive barriers for treatment of inorganic contaminants for at least two new types of sites</b>		<b>FY07</b>	<b>NRMRL</b>	<b>i</b>
	Report on the application and performance of permeable reactive barrier technology for ground water remediation at contaminated sites (APM 03-137 linked to APG 03-11)).	FY03	NRMRL Rick Wilkin	i
	Report on field application of PRBs to remediate arsenic contamination in ground water	FY06	NRMRL Rick Wilkin	i
	Report on evaluation and optimization of sampling techniques for collection and preservation of solids from saturated or suboxic zones	FY05	NRMRL Rick Wilkin	i
	Report on microbial processes in acid mine drainage	FY06	NRMRL Rick Wilkin	i
	State-of-the-art monitoring methods for long-term performance of PRBs.	FY07	NRMRL Bob Puls	i
	Report on field evaluation of PRBs for acid mine drainage	FY07	NRMRL Rick Wilkin	i
<b>By FY09 provide tools for cost-effective long-term performance assessment of MNA for inorganics at waste sites</b>		<b>FY09</b>	<b>NRMRL</b>	<b>i</b>
	Issue paper on decision support tool for MNA of specific inorganic contaminants	FY04	NRMRL Robert Ford	i
	Decision support framework for monitored natural attenuation of inorganic contaminants.	FY05	NRMRL Bob Puls	i
	Report on metal attenuation processes at mining megasites.	FY07	NRMRL Rick Wilkin	i
	Report evaluation use of the decision support framework for MNA of inorganics	FY08	NRMRL Robert Ford	i
	Report on long term performance of inorganics MNA (synthesis report)	FY09	NRMRL Robert Ford	i

LUST Fuel and Fuel Oxygenates				
By FY07 complete a synthesis document of use of TACS for modeling fate and transport of fuel components		FY07	NERL	i
	Document on identifying and predicting plume diving behavior	FY03	NRMRL John Wilson	i
	Database of gasoline compositional data for use in source term modeling	FY04	NERL Jim Weaver	i
	Version 1 of software to evaluate data using a coordinated data management system and suite of models (Tools for Analysis of Contaminated Sites (TACS)) (APM 04-233 linked to APG 06-138; relink to FY07 APG)	FY04	NERL Jim Weaver	i
	Version 1 of model to assess exposure from vapor intrusion	FY04	NRMRL Dom DiGuilio	i
	Improved approaches to source term and transport modeling evaluations based upon lab/field studies for inclusion in the TACS software	FY05	NERL Jim Weaver	i
	Version 2 of Tools for Analysis of Contaminated Sites (TACS), revised with Version 1 user input	FY06	NERL Jim Weaver	i
By FY05 provide a enhanced on-line calculator web site with eight training modules		FY05	NERL	i
	Web-enabled software for evaluating biodegradation constants	FY03	NERL Jim Weaver	i
	Enhanced on-line calculator web site with four fate and transport training modules.	FY04	NERL Jim Weaver	i
	Enhanced on-line calculator with four modeling training modules	FY05	NERL Jim Weaver	i
Provide 4 improved methods for remediation and containment of subsurface contamination by alternative oxygenates (APG 05-113)		FY05	NRMRL	i
	Journal article on ex situ biotreatment of ground water contaminated with MTBE and fuel hydrocarbons (APG 03-164 linked to APG 03-11)	FY03	NRMRL	i
	Report on preliminary lab evaluation of the fate and transport of co-disposed oxygenates	FY03	NRMRL	i
	Report on optimization of Fenton's reagent to treat MTBE	FY03	NRMRL	i
	Document on rate and extent of biodegradation and sorption of MTBE and ethanol	FY03	NRMRL	i
	Report on performance of surfactant flush to remove gasoline from ground water	FY03	NRMRL	i

	Synthesis report on the monitored natural attenuation of fuel additives as a risk management option at leaking underground storage tank sites (APM 04-71)	FY04	NRMRL John Wilson	i
	Report on field evaluation of source hydraulic isolation	FY04	NRMRL John Wilson	i
	Report on field evaluation of infiltration gallery to contain and treat ethanol	FY04	NRMRL Carl Enfield	i
	Report on field evaluation of infiltration gallery to contain and treat MTBE	FY05	NRMRL Carl Enfield	i
<b>Capstone report on in situ and ex situ treatment approaches for fuel oxygenates</b>		<b>FY09</b>	<b>NRMRL</b>	i
	Report on monitored natural attenuation of TBA	FY06	NRMRL John Wilson	i
	Report on treatability of alkylates as fuel oxygenates	FY06	NRMRL Fran Kremer	i
	Report on treatment of TBA, TAME, DIPE, and EDBE	FY07	NRMRL Fran Kremer	i
	Report on evaluation of treatment options for alternative oxygenates	FY07	NRMRL Fran Kremer	i
	Capstone report on ex situ biological treatment of fuel oxygenates	FY07	NRMRL Fran Kremer	i
	Report on monitored natural attenuation of TAME, DIPE, and EDBE	FY08	NRMRL John Wilson	i
<b>Complex hydrogeology and alternate pathways</b>				
<b>By FY05 evaluate the role of complex hydrogeology and potential transport paths in characterization or remediation of at least three sites</b>		<b>FY05</b>	<b>NRMRL</b>	i
GW/ SW	Provide expertise and technical support regarding ground water tracing of pollutants in Karst geologic formations (APM 03-168 linked to APG 03-9)	FY03	NCEA Malcolm Field	i
	Report on the impact of ground water/surface water interactions on contaminant transport and fate at contaminated sites (APM 04-73)	FY04	NRMRL Robert Ford	i
	Report on the ecological risk of exposure to ground water toxic metals released to surface water	FY05	NCER Mitch Lasat	i
	Report on field study of mercury transformations at the GW/SW interface.	FY05	NRMRL Robert Ford	i

	Report on 3 case studies of the impact of ground water/surface water interactions on contaminant transport and fate	FY05	NRMRL Robert Ford	i
VI	Investigation of ground water / indoor air pathway for DNAPL plume at Raymark Superfund site.	FY05	NRMRL Dom Digiulio	i
<b>By FY09 provide guidance on cost effective approaches for characterization and remediation in fractured rock settings</b>		<b>FY09</b>	<b>NRMRL</b>	i
	Remedial methods for in situ treatment of TCE in fractured rock	FY05	NRMRL Mary Gonsolin	i
	Performance evaluation of a site for characterization and remediation in fractured rock	FY06	NRMRL Eva Davis	i
	Summary report for characterization and remediation of recalcitrant organic compounds in fractured rock	FY09	NRMRL	i

**Table A-3. Long-term Goal 3–Soil/Land**

<b>Long-term goal 3:</b> By 2010, 25 tools and methods will be provided that will allow the Agency to accurately and efficiently assess, remediate, and manage the soil and land in a healthy, productive, and sustainable state				
<b>By 2007, to advance the state of inorganic analyses and obtain lower detection limits, better speciation, and quantification in both the field and laboratory, 5 analytical techniques, methods, and instruments will be developed and evaluated.</b>		<b>FY07</b>	<b>NERL</b>	i
Cr	Rapid field methods for hexavalent chromium. Will provide rapid, cost-effective analytical tools for SF site managers, regional offices, and other stakeholders (APM 03-24 linked to APG 03-10)). Delayed by FY03 resource reduction	FY04	NERL Kim Rogers	i
	Report on the feasibility of electrophoresis for determining chromium speciation (APM 04-325)	FY04	NCER Mitch Lasat	i
Hg	Reports on results of mercury determination in soils SITE demonstration of characterization technologies under controlled conditions to develop independent technical performance data	FY04	NERL Steve Billets	i
	Field sampling guidance document to identify methods and techniques to eliminate bias that occurs during field sampling (guidance document)	FY07	NERL John Nocerino	i
<b>By 2010, to advance the state of organic analyses and obtain lower detection limits, better identification and quantification in both the field and laboratory, 15 analytical techniques, methods, and instruments will be developed and evaluated.</b>		<b>FY10</b>	<b>NERL</b>	i
VOCs	Effectiveness of a new prototype soil sampler for the collection of VOC-contaminated soils that effectively reduces the losses of VOCs during sample transfer from core to VOA vial (journal article and fact sheet)	FY03	NERL Brian Schumacher	i
	Completion, delivery, and inter-laboratory study of six Vacuum Distillation units to various EPA Regions for VOA analyses (report, deliverable) (APM 04-209)	FY04	NERL Mike Hiatt	i
	Guide to sampling soils contaminated with volatile organic compounds (synthesis report: guidance document)	FY05	NERL Brian Schumacher	i
	Use of a chemical sensor array for the rapid, in-situ determination of soil VOCs. (report or journal article)	FY07	NERL Kim Rogers	i
	Report on initial dog/handler training for a suite of test substances for rapid in-field detection of pollutants	FY03	NERL Sandy Bird	i
	Report on field proofing exercises and initial field demonstration of pollution detecting dogs	FY04	NERL Sandy Bird	i

PAHs	Report on monitoring of PAHs in the environment by immunoassay as a screening tool to streamline expensive analysis of these common contaminants	FY05	NERL Jeanette van Emon	i
PCBs	Report on Comparison of GC and Immunoassay for PCB Soil Samples to Support Decision-Making for Cost-Effective Field Analytical Methods for Superfund Site Characterization (APM 03-25). Delayed by FY03 resource reduction.	FY04	NERL Jeanette van Emon	i
	Comparison of GC/MS and Immunoassay for Analysis of Co-Planar PCBs. Delayed by FY03 resource reduction.	FY06	NERL Jeanette van Emon	i
	Comparison of gas chromatography/mass spectrometry and immunoassay for analysis of co-planar polychlorinated biphenyls . Pre-screening samples with relatively inexpensive congener-specific ELISAs may reduce or eliminate the expensive instrumental analysis of samples that contain little or no co-planar PCBs. (journal article and fact sheet)	FY06	NERL Jeanette van Emon	i
Dioxins	Reports on results of SITE demonstrations of characterization technologies tested for dioxins in soil (APM 03-05 linked to APG 03-10)	FY03	NERL Steve Billets	i
	Comparison of bioanalytical methods for dioxins in soil and sediments to reduce the time and high cost of conventional analysis.	FY08	NERL Kim Rogers	i
<b>By 2008, better prediction of contaminant movement in soils and their potentially harmful effects to human health through dermal absorption will be evaluated through the development of 2 procedures, models, or assessments</b>		<b>FY08</b>	<b>NCEA</b>	i
	Methods, models, and factors relating to the evaluation of risks from the dermal route of exposure	FY03	NERL Curt Dary	i
	Publish study on evaluation of dermal absorption model for contaminants in soil	FY07	NCEA Mike Dellarco	i
<b>Provide field study results and methodologies for soil remedies and cover/liner materials used in containment technologies (APG 06-141)</b>		<b>FY06</b>	<b>NRMRL</b>	i
Covers	Journal article/summary of alternative cover assessment techniques to provide innovative cost-effective approaches in managing landfills and waste sites (APM 03-161 linked to APG 03-11)	FY03	NRMRL Steve Rock Dave Carson	i
	Journal article on phytotechnology for infiltration control and ground water plume control (APM 03-159 linked to APG 03-11)	FY03	NRMRL Steve Rock	i
	Report on multi-layer GCL performance in the field relating slope stability to GCL application	FY04	NRMRL Dave Carson	i

	Report on chemical stability of GCLs during lab permeability testing	FY04	NRMRL Jennifer Goetz	i
	Report on physical/chemical stability of geosynthetic clay liners and compacted clay liners (APM 03-261 linked to APG 06-141, which we may not want anymore)	FY04	NRMRL Dave Carson	i
	ACAP final report to present conclusions from the field study and to recommend monitoring and construction guidelines for alternative covers (synthesis report)	FY05	NRMRL Steve Rock	i
	Report on non-destructive liner testing technology	FY05	NRMRL Dave Carson	i
	Report on long-term performance of containment systems	FY06	NRMRL	i
mine remediation	Complete demonstration of 5 innovative technologies for mine site remediation (APM 04-77 linked to APG 04-6)	FY04	NRMRL Annette Gatchett	i
metals	Report on the evaluation of managed natural systems for toxic metal removal (APM 04-327)	FY04	NCER Mitch Lasat	i
<b>By 2010, 15 land management options will be evaluated to provide decision makers with tools to select the best land management option(s) to protect human health and the environment and foster reutilization</b>		<b>FY10</b>	<b>NRMRL</b>	<b>i</b>
Landfill management	Report on application of guidance document for characterizing landfill gas emissions at Superfund landfills	FY04	NRMRL Susan Thorneloe	i
	Guidance on evaluating the air pathway at Superfund landfills	FY05	NRMRL Susan Thorneloe	i
	Protocol document for design and evaluation of alternative covers	FY07	NRMRL Steve Rock	i
	Report on next generation of technologies for characterizing fugitive gas emissions from Superfund landfills	FY09	NRMRL Susan Thorneloe	i
	Report on non-destructive construction quality control techniques for waste containment systems	FY09	NRMRL Dave Carson	i
	Synthesis report on covers and containment technologies	FY10	NRMRL Dave Carson	i
Remediation	Journal article on metal bioavailability to provide a better understanding of reduced risk as a result of metal immobilization (APM 03-158 linked to APG 03-11)	FY03	NRMRL Jim Ryan	i
	Evaluate the effectiveness of microbial indicators to predict the potential, and monitor the success of bioremediation.	FY05	NCER Mitch Lasat	i

	Report on linking molecular analysis of microbial populations with potential for degradation of PAHs.	FY05	NCER Mitch Lasat	i
	Report on the evaluation of managed natural systems for degradation of organic contaminants	FY05	NCER Mitch Lasat	i
	Report on the use of zero-valent metals for treating organohalides found in offgas from SVE systems.	FY05	NCER Mitch Lasat	i
Reutilization /Recovery	CD-ROM report on workshop on economic tools for redeveloping sites (OSWER Brownfields/OSP/SITE funding)	FY03	NRMRL Ann Vega	i
	Searchable database of characterization, monitoring, and remediation tools and technologies applicable to Brownfields (OSWER Brownfields funding)	FY03	NRMRL Ann Vega	i
	Report on effectiveness of restoration practices for improving water quality (from Goal 8)	FY03	NRMRL Eric Jorgensen	i
	Workshop on risk assessment for brownfields (OSP funding)	FY03	NRMRL Ann Vega	i
	Product from workshop on risk assessment for redevelopment (OSP funding)	FY04	NRMRL Ann Vega	i
	Primer on environmental, financial, and social considerations for redevelopment projects, with compilation of resources and experience (SMART plan - <b>Site-specific Management Approaches and Redevelopment Tools</b> ) (OSWER Brownfields funding)	FY04	NRMRL Ann Vega	i
	Journal article on sustainability indicators (inhouse; no cost)	FY04	NRMRL Verle Hansen	i
	Report on the recovery of a stream ecosystem from mining pollution	FY05	NCER Mitch Lasat	i
	Case studies on land use options for reuse of remediated Superfund sites	FY09	NRMRL Fran Kremer	i



**Table A-4. Long-term Goal 4–Multimedia**

<b>Long-term goal 4:</b> By 2010, provide 40 scientific tools, methods, and models, as well as technical support to (1) characterize the nature and extent of multimedia site contamination; (2) assess, predict, and communicate risks to human health and the environment; (3) evaluate innovative characterization and remediation options; and (4) develop testing protocols, risk management strategies, and identify fate and effects of oil spills				
<b>Exposure Assessment</b>				
<b>Provide methods, models, factors, assessments, and technical support to OERR, Regional, State, Tribal, and Local Offices to estimate health and ecological risks from exposure to CERCLA hazardous substances (APG 03-9)</b>		<b>FY03</b>	<b>NCEA</b>	i
	Analyze USDA food consumption data and make data electronically accessible	FY03	NCEA Jackie Moya	i
	Develop distributions of fat intake. These distributions will be combined with measurements of concentrations of lipophylic contaminants in food-products fat to derive estimates of exposure for human populations.	FY03	NCEA Jackie Moya	i
<b>Deliver user-friendly, state-of-the-science methods and technology reports to OSWER, Regions, States, industry and consultants to cost-effectively characterize Superfund hazardous waste sites and protect health and environment (APG 03-10)</b>		<b>FY03</b>	<b>NERL</b>	i
	Rapid field methods for hexavalent chromium that will provide rapid, cost-effective analytical tools for SF site managers, regional offices, and other stakeholders (method report or journal article) (APM 03-24). Delayed by FY03 resource reduction.	FY04	NERL Kim Rogers	i
<b>Develop ten (10) new statistical procedures, analytical methods, exposure factors, methods, and models that produce faster, more accurate, and less costly estimates of exposure to Superfund contaminants.</b>		<b>FY08</b>	<b>NERL</b>	i
Chemistry	Manuals documenting the software and instructional video on Ion Composition Elucidation (ICE) experiments will be prepared and provided to the Regions so each Region can investigate tentatively identified compounds (TICs) in multiple media.	FY03	NERL Andy Grange	i
	A rapid turn-around screening method for Aroclor identification and quantification in multiple media using MPPSIRD (journal article and fact sheet) (APM 04-208)	FY04	NERL Andy Grange	i
	Measurement of windblown semivolatile contaminants and assessment of ecological exposure - methodology and case study.	FY05	NERL Ed Heithmar	i

	Development of sensitive, reliable, and cost-effective elemental speciation methods to measure the toxic and mobile forms of inorganic contaminants (e.g., As, Se, Sn, Hg, etc.).	FY05	NERL Georges-Marie Momplaisir, Charlita Rosal	i
	Conduct methyl mercury analyses of liver and muscle for fish from Superfund mercury-impacted areas; and compare a faster, more-economical methodology with the conventional methodology	FY06	NERL Tom Hinner	i
	Semi-permeable membrane devices (SPMDs) for forensic environmental investigation of congener-specific polychlorinated biphenyls, using an isotope dilution mass spectrometry method	FY07	NERL Lantis Osemwengie	i
Statistics	SCOUT statistical software package upgrade containing new robust statistical procedures and the geostatistical model that allow for more advanced statistical techniques to be used in the assessment of the validity of analytical data. (updated version and fact sheet)	FY05	NERL John Nocerino	i
	Synthesis Report: Robust statistics with environmental applications to provide OERR/Regions with a compendium of statistical methods that are available to assess the validity of analytical data. (guidance document)	FY06	NERL John Nocerino	i
	Guidance document on robust statistical methods with an emphasis on environmental applications (synthesis report)	FY08	NERL John Nocerino	i
Exposure Factors	Child-Specific Exposure Factors Handbook (APM 04-107)	FY04	NCEA Jackie Moya	i
	Develop ranges of soil ingestion rates among children	FY04	NCEA Jackie Moya	i
	Publish study on measuring dermal permeability coefficients for lipophilic compounds in water	FY05	NCEA Mike Dellarco	i
	Publish study on evaluation of dermal absorption model for contaminants in water	FY05	NCEA Mike Dellarco	i
	External review draft summarizing an analysis of correlations in short term food consumption to evaluate potential applications for use in probabilistic exposure assessment (APM 04-102)	FY04	NCEA Jackie Moya	i
<b>Toxicity Assessment</b>				
<b>Provide 6 toxicity and dose-response assessments of contaminants of high interest to the Superfund program using 1state-of-the-art methods and models</b>		<b>FY08</b>	<b>NCEA</b>	<b>i</b>
Lead model	Final maternal/fetal component for the AAL model	FY03	NCEA Rob Elias	i

	Plan uncertainty analysis component for the AAL model	FY03	NCEA Rob Elias	i
	Final uncertainty analysis component for the AAL model	FY04	NCEA Rob Elias	i
	Model for estimating human exposure to multiple metal contaminants using biokinetic modeling techniques	FY06	NCEA Rob Elias	i
PCBs	Complete external review draft of a health assessment of non-cancer PCB health effects (APM 04-313)	FY04	NCEA Bob Sonawane	i
metals	Complete study of the confounding effects of arsenic and the toxicity of cadmium at smelting facilities	FY04	NCEA Rob Elias	i
	Journal article submitted for publication on the ecological effects of selenium on soil invertebrates to address data gaps that are currently limiting the development of soil screening limits for selenium. (APM 04-314)	FY04	NCEA Keith Sappington	i
mixtures	Evaluate the carcinogenic potency of complex chemical mixtures	FY05	NCER Mitch Lasat	i
	Report on the regulation of embryonic neuronal development by chemical mixtures	FY05	NCER Mitch Lasat	i
	Develop and evaluate algorithms to predict the toxicity of chemical mixtures	FY05	NCER Mitch Lasat	i
	Report on the immunotoxic potential of mixtures of organochlorines on the immune functions of humans and different species of marine mammals	FY05	NCER Mitch Lasat	i
<b>Deliver assessments of effects of exposure to chemicals on human health and the environment to EPA, other governmental organizations, industry, consultants, academics and nongovernmental organizations to promote scientifically sound consistent risk assessments to enhance protection of human health. (Goal 7 APG 03-67)</b>		<b>FY03</b>	<b>NCEA</b>	i
	Submit for external review human health assessments for 6 high priority substances (Goal 7 APM 03-256)	FY03	NCEA Amy Mills	i
<b>Through IRIS, initiate or submit 30 health assessments to external review and complete 4 human health assessments. (Goal 7, APG 04-27)</b>		<b>FY04</b>	<b>NCEA</b>	i
	Complete 4 human health assessments and publish their results on the IRIS web site (Goal 7, APM 04-109)	FY04	NCEA Amy Mills	i
	Initiate or submit to external peer review human health assessments of 30 high priority chemicals (Goal 7, APM 04-138)	FY04	NCEA Amy Mills	i

<b>Oil Spills</b>				
<b>To ensure cost-effective and technically sound site clean-up, deliver state-of-the-art guidance and methods to EPA and other stakeholders for risk management of...oil spills (APG 03-11)</b>		<b>FY03</b>	<b>NCER</b>	i
	The effect of plants on the bioavailability and toxicity of contaminants in soil (simulated diesel fuel) - grant number R825413.	FY03	NCER Mitch Lasat	i
<b>Development of protocols for testing effectiveness of bioremediation products, dispersants, surface washing agents, other products, and spills of opportunity (APG 05-28)</b>		FY05		i
	Final report on bioremediation product effectiveness protocol in freshwater and saltwater.	FY03	NRMRL Al Venosa	i
	Report on efficacy of bioremediation products	FY03	NRMRL Al Venosa	
	Final report on surface washing agent effectiveness protocol	FY04	NRMRL Al Venosa	i
	Final report on spill of opportunity protocol	FY04	NRMRL Al Venosa	i
	Final report on effectiveness of dispersants in the field (APM 04-79)	FY04	NRMRL Al Venosa	i
<b>Development of risk management strategies for petroleum oil spills at all temperatures in fresh and saline environments</b>		<b>FY07</b>	<b>NRMRL</b>	i
	Report on use of chemical oxidation and bioremediation for treating Indiana Harbor Canal sediment	FY04	NRMRL Al Venosa	i
	Report on biodegradability of dispersed oil at different temperatures	FY04	NRMRL Al Venosa	i
	Report on clay-oil flocculation & nutrient effects on treating oil slicks on lake surfaces	FY06	NRMRL Al Venosa	i
<b>Identify fate and effects of oil spills and transported oil in fresh and saline environments (APG 07-139)</b>		FY07		i
modeling	Report on climatic data for oil spill modeling	FY03	NERL Jim Weaver	i
	Report on data-driven approaches for Orimulsion modeling	FY03	NERL Jim Weaver	i
	Report on oil spill and dispersant model, including tested software, database of required input parameters, and users guide for pilot testing	FY03	NERL Jim Weaver	i
	Report on detailed composition and composition-dependent properties of crude oils of interest to OPC.	FY03	NERL Jim Weaver	i

	Interim report on adaptation of the oil spill model for Orimulsion® and vegetable oil modeling	FY04	NERL Jim Weaver	i
	Report on comparison of ecosystem exposure resulting from various response scenarios, including tested software and users guide (APG 04-232)	FY04	NERL Jim Weaver	i
	Simulation of a tidal marsh to support oil spill modeling and generate field data	FY04	NERL Jim Weaver	i
	Report on Orimulsion modeling, including tested software and Internet-based users guide.	FY05	NERL Jim Weaver	i
	Report on comparison of ecosystem exposure resulting from various response scenarios for Orimulsion spills	FY05	NERL Jim Weaver	i
	Report on linkage of the oil spill model with multimedia modeling frameworks and their uncertainty analysis	FY06	NERL Jim Weaver	i
	Report on evaluation of the multimedia approach to simulating oil spills	FY07	NERL Jim Weaver	i
fate & effects	Interim report on biodegradability of Orimulsion and heavy oils	FY03	NRMRL Al Venosa	i
	Report on eco-effects of oil spills in fresh and saline environments	FY03	NRMRL Al Venosa	i
	Gas chromatography-isotope ratio mass spectrometry- a novel approach for monitoring the origin and fate of hydrocarbon contaminants in the environment - grant number R826178.	FY03	NCER Bala Krishnan	i
	Report on fate and effects of oil spills in cold climates	FY05	NRMRL Al Venosa	i
<b>Development of risk management strategies for non-petroleum oil spills in all environments</b>		<b>FY08</b>	<b>NRMRL</b>	<b>i</b>
	Report on cost-effective, innovative risk management options to biodegrade non-petroleum oils in freshwater environments (APM 03-165 linked to APG 03-11)	FY03	NRMRL Al Venosa	i
	Report on field studies of innovative ways to manage non-petroleum oil spills in freshwater environments (lakes and lake sediments) at mesophilic temperatures	FY05	NRMRL Al Venosa	i
	Report on innovative ways to biodegrade non-petroleum oils in freshwater environments	FY06	NRMRL Al Venosa	i
	Report on field studies of innovative ways to manage non-petroleum oil spills in freshwater environments at cold temperatures	FY07	NRMRL Al Venosa	i

<b>Technical Support</b>				
<b>Summarize technical support accomplishments that assist OERR and the Regions select and implement options for site characterization, risk assessment, and clean up annually at more than 100 sites across the country</b>		<b>FY08</b>	<b>NRMRL, NERL, NCEA, NCER</b>	<b>i</b>
	Report summarizing ORD Superfund technical support for FY99 to FY01, including trends analysis.	FY03	NRMRL, NERL, NCEA Trish Erickson	i
	Annual Report on Superfund Health Risk and Ecological Risk Assessment Support Centers for 2002 (APM03-75 linked to APG03-10)	FY03	NCEA Harlal Choudhury, Mike Kravitz	i
	Technical assistance by Hazardous Substance Research Centers (HSRCs) to communities affected by hazardous substance problems - summarized in HSRC annual reports	FY03	NCER Mitch Lasat	i
	Report summarizing ORD Superfund technical support for FY02 to FY04, including trends analysis.	FY05	NRMRL, NERL, NCEA Trish Erickson	i
	Report summarizing ORD Superfund technical support for FY05 to FY07, including trends analysis.	FY08	NRMRL, NERL, NCEA Trish Erickson	i
<b>Superfund Innovative Technology Evaluation (SITE) Program</b>				
<b>Between FY03 and FY05, complete at least 10 SITE demonstrations, with emphasis on NAPLs and sediments</b>		<b>FY05</b>	<b>NRMRL</b>	<b>i</b>
	Draft of Annual (FY02) SITE Report to Congress (APM 03-226 linked to APG 03-11–APG wording shown under oil spills)	FY03	NRMRL, NERL Annette Gatchett	i
	Verification reports on selective innovative technologies to determine dioxins in soils to meet regional needs for site characterization and measurement methods (APM 04-211)	FY04	NERL Steve Billets	i
	Provide data for use in NRMRL's Annual SITE program progress report (APM 04-213)	FY04	NERL Steve Billets	i
	Draft of Annual (FY03) SITE Report to Congress (APM 04-76)	FY04	NRMRL Annette Gatchett	i
	Draft of Annual (FY04) SITE Report to Congress	FY05	NRMRL, NERL Annette Gatchett	i

<b>Between FY06 and FY08, complete at least 10 SITE characterization, monitoring, and treatment demonstrations, with emphasis on problems identified by clients</b>		<b>FY08</b>	<b>NRMRL</b>	i
	Draft of Annual (FY05) SITE Report to Congress	FY06	NRMRL, NERL Annette Gatchett	i
	Draft of Annual (FY06) SITE Report to Congress	FY07	NRMRL, NERL Annette Gatchett	i
	Draft of Annual (FY07) SITE Report to Congress	FY08	NRMRL, NERL Annette Gatchett	i

## Appendix B - ORD Superfund and RCRA CA Technical Support

### Laboratory/Center Contacts for General Information:

National Center for Environmental Assessment (NCEA)	Kevin Garrahan	202-564-3336
National Center for Environmental Research (NCER) (Including Hazardous Substances Research Centers)	Mitch Lasat	202-564-6826
National Exposure Research Laboratory (NERL)	Dermont Bouchard	706-355-8333
National Health and Environmental Effects Research Laboratory (NHEERL)	Bob Dyer	919-541-2760
National Risk Management Research Laboratory (NRMRL)	Trish Erickson	513-569-7406
Office of Science Policy (OSP)/Hazardous Substance Technical Liaison Program	Randy Wentsel	202-564-3214

### Contaminated Sites - Site Specific Technical Support

This technical support area consolidates activities which provide site-specific technical support for characterization, modeling, monitoring, assessment and remediation of contaminated sites under Superfund and, in some cases, under RCRA Corrective Actions. Specific elements included are:

**Environmental Photographic Interpretation Center (EPIC) - Contact: Donald Garofalo, 703-648-4285.** <http://lvord1.las.epa.gov:9876/epic/default.htm> This center provides site-specific information on the condition and activities occurring at hazardous waste disposal sites at a point in time or over a historical period; documents these conditions and changes; provide guides in the form of reports, maps, and photographs for assisting in the safe cleanup of hazardous waste materials; and assists in emergency response and enforcement efforts when requested by client offices. Remote sensing technical support is provided to all EPA Regional Superfund Offices and OERR, and includes: hazardous waste disposal site characterization and mapping; annotated aerial photo interpretation reports; topographic mapping of waste disposal sites; acquisition of aerial photographs; and enforcement support.

**Monitoring and Site Characterization Technology Support Center - Contact: J. Gareth Pearson, 702-798-2270.** <http://www.epa.gov/nerlesd1/tsc/tsc.htm> - This center provides scientific and technical assistance in the characterization of hazardous waste sites and associated site contaminants. State-of-the-science methods and technologies are identified and applied to identify contaminants, determine their levels and concentrations, and identify their geographic extent and distribution for site characterization and remediation.

**Center for Exposure Assessment Modeling (CEAM) - Contact: Frank Stancil, 706-355-8100.** <http://www.epa.gov/ceampubl/ceamhome.htm> - CEAM's goals are to develop, maintain, and apply state-of-the-science technical tools including multimedia exposure and ecosystem response simulation models, environmental databases, data analysis packages, tool application strategies, and advanced educational materials in the environmental sciences.

**Center for Subsurface Modeling Support (CSMoS) - Contact: David Jewett 580-436-8560 .**



<http://www.epa.gov/ada/csmos.html> - Provides support for development, testing, application, and distribution of models on fate and transport of contaminants in the subsurface environment.

**Engineering Technical Support Center (ETSC) and Superfund Technical Assistance Response Team (START) - Contact: Dave Reisman 513-569-7588.** This center provides site-specific assistance on engineering and treatment issues during any phase of a site cleanup. Focus areas include containment, thermal treatments, soil vapor extraction, bioremediation, and solidification/stabilization. Support is provided for incorporating technology-based data needs in the RI/FS phase and conducting/evaluating site-specific remedy options in the RD/RA and post-construction phases. The center publishes Engineering Bulletins on technologies and site types. The center supports Superfund, Brownfields, and RCRA Corrective Action sites.

**Ground Water Technical Support Center (GWTSC) - Contact: Dave Burden 580-436-8606.** <http://www.epa.gov/ada/tsc.html> - This center provides site-specific assistance on ground water and subsurface contamination problems in site remediation. Focus areas include in-situ water treatment, in-situ thermal treatment, monitored natural attenuation, soil vapor extraction, and permeable reactive barriers. The center also publishes issue papers on subsurface remediation and ground water topics and provides project manager training upon request by the regions. The center supports Superfund, Brownfields, and RCRA Corrective Action sites.

**Superfund Health Risk Technical Support Center - Contact: Harlal Choudhury 513/569-7536.** The Superfund Health Risk Technical Support Center (STSC) supports regional and headquarters Superfund risk assessors by reviewing and developing exposure and toxicity factors that allow more accurate quantitative estimates of risk to be developed. Much of the activity is focused on developing new and updated peer reviewed provisional toxicity values that describe dose-response toxicological relationships. External peer review of the provisional toxicity values was initiated in FY1999. The Center also provides user support through the STSC Hotline, as well as onsite expertise reviews. All assistance is provided on a rapid turn-around basis.

**Ecological Risk Assessment Technical Support Center (Michael Kravitz 513-569-7140)**  
The Ecological Risk Assessment Support Center (ERASC) will provide technical and management support and arranging for scientific review and consistency on topics relevant to ecological risk assessment and ecological concerns. NCEA will manage the Center, but it is understood that it will routinely be necessary to access the expertise that is located in various ORD laboratories and centers. The Center Director will arrange for this access as appropriate. During the FY01 pilot program, an Implementation Committee consisting of members from the Office of Research and Development, the Office of Solid Waste and Emergency Response, and EPA regional offices will provide oversight and guidance for formation of the ERASC and its guiding principles.

**Hazardous Substance Technical Liaison Program - Coordinator: Randy Wentsel 202-564-3214**  
Provides ORD representatives to regions to support regional integration of technology and coordination with ORD.

<b>R1</b>	<b>Stephen Mangion</b>	<b>617-918-1452</b>	<b>R7</b>	<b>Robert Mournighan</b>	<b>913-551-7913</b>
<b>R2</b>	<b>Jon Josephs</b>	<b>212-637-4317</b>	<b>R8</b>	<b>Jim Dunn</b>	<b>303-312-6573</b>
<b>R3</b>	<b>Norman Kulujian</b>	<b>215-814-3130</b>	<b>R9</b>	<b>Michael Gill</b>	<b>415-972-3054</b>
<b>R4</b>	<b>Felicia Barnett</b>	<b>404-562-8659</b>	<b>R10</b>	<b>John Barich</b>	<b>206-553-8562</b>

## **Appendix C - Draft Strategic Land Goal**

### **Goal 3: Preserve and Restore the Land<sup>2</sup>.**

Preserve and restore the land by reducing and controlling risks posed by releases of harmful substances; promoting waste diversion, recycling, and innovative waste management practices; and cleaning up contaminated properties to levels appropriate for their beneficial reuse.

**Objective 1: Preparedness and Response.** By 2008, reduce and control the risks posed by accidental and intentional releases of harmful substances by improving our nation's capability to prevent and respond more effectively to these emergencies.

**Sub-Objective 1.1:** By 2008, improve the Agency's emergency preparedness capability by achieving and maintaining the capability to respond to five simultaneous large-scale emergencies, and increasing response readiness by XX% (from a baseline established in 2003). Also, facilitate rapid and effective emergency response across the Agency and all levels of government by improving coordination and communication.

**Sub-Objective 1.2:** By 2008, respond to XXX releases of hazardous substances and XXX oil spills. (Note: subsequent versions of this strategic plan should include a measure for effectiveness of response.)

**Sub-Objective 1.3:** By 2008, reduce releases to the environment from oil facilities by increasing the number of those facilities in compliance from XXX to 6,000.

**Objective 2: Prevention & Conservation.** By 2008, reduce adverse effects on land by reducing waste generation, increasing waste recycling, and ensuring proper management of waste and petroleum products at facilities in ways that prevent dangerous releases.

**Sub-Objective 2.1:** By 2008, reduce adverse effects of harmful substances on land by reducing the national average municipal solid waste generation from XX to YY pounds per person per day and increasing the municipal solid waste recycling to at least X% from Y%. Also, increase the recycling of hazardous substance in the XXX sectors from XX% to YY%.

**Sub-Objective 2.2:** By 2008, reduce releases to the environment from underground storage tanks (USTs) by increasing the percentage of UST facilities that are in significant operational compliance from XX to YY, and by decreasing the number of confirmed releases reported annually.

**Sub-Objective 2.3:** By 2008, prevent dangerous releases to the environment from RCRA hazardous waste management facilities by increasing the percentage of those facilities that have approved controls in place from X to Y.

**Objective 3:** By 2008, control the risks to human health and the environment at contaminated properties or sites, and make land available for reuse.

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<sup>2</sup> These programmatic goals are from the draft released 12/31/02 for public comment. Updated information will be posted at [www.epa.gov/ocfo/...](http://www.epa.gov/ocfo/...)

**Sub-Objective 3.1:** By 2008, risks to human health and the environment at contaminated sites will be controlled through cleanup, assessment, stabilization, or other action.

**Sub-Objective 3.2:** Through 2008, X units of land will be made available for reuse through cleanup, assessment, stabilization, or other action which indicates that such lands are restored to levels that are protective for the next reasonably anticipated future land use. (Note: This sub-objective does not call for additional state reporting.) (Total amount of land measured to be comprised of X units from RCRA, X acres from Superfund, and X units from Underground Storage Tank facilities.)

**Objective 4:** Science/Research. Through 2010, provide and apply a sound scientific foundation to EPA's goal of preserving and restoring the land by conducting leading-edge research and developing a better understanding and characterization of environmental outcomes under Goal 3.

**Sub-Objective 4.1: Science to Support Land Goal.** Through 2008, provide the most current, sound scientific infrastructure that will provide a foundation for preservation of land quality and remediation of contaminated land.

**Sub-Objective 4.2: Research.** Through 2010, conduct leading-edge, sound scientific research to provide a foundation for preservation of land quality and remediation of contaminated land. Research will result in documented methods, models, assessments, and risk management options for Program and Regional Offices, facilitating their accurate evaluation of effects on human health and the environment, understanding of exposure pathways, and implementation of effective risk management options.

## Appendix D - Research Needs

### Superfund and Oil Program Research Priorities – March 2003

In addition to the research needs listed below, the program continues to highly value ORD technical support on site-specific issues (provided both by through the Technical Support Centers and through other mechanisms) and technical support to OERR staff on guidance development.

The Superfund and Oil program research needs are organized into the following categories:

#### Superfund Research Needs

##### I. GROUND WATER RESEARCH NEEDS

All of these items are of high priority, although they are generally listed in order of priority. OERR Contact: Ken Lovelace

###### GW-1. Technical Support

- 1a. Providing technical assistance to EPA regional staff for site specific issues related to characterization, evaluation (e.g., modeling) remediation of contaminated ground water.
- 1b. Providing technical assistance to EPA HQ staff for guidance development (e.g., serving on workgroups and/or technical reviews of draft documents).

###### GW-2. Natural Attenuation/Bioremediation Processes

- 2a. Research of attenuation (physical, chemical, biologic) processes affecting inorganic (metals and metalloids) and radiologic contaminants in ground water. This includes basic research on relevant processes, and potential methods for enhancing natural processes.
- 2b. Research of attenuation (physical, chemical, biologic) processes affecting recalcitrant organic contaminants (e.g., semivolatile compounds, pesticides) in ground water. This includes basic research on relevant processes, and potential methods for enhancing natural processes.
- 2c. Research of methods to enhance bioremediation of contaminants in ground water.
- 2d. Research and development of improved methods for evaluating long-term performance of monitored natural attenuation (MNA) remedies, including plume stability, changes in hydraulic conditions, changes in biogeochemical environment, discharges to surface water (see “emerging issues,” below), and impacts on indoor air (see “emerging issues,” below).
- 2e. Development and application of natural attenuation research. This includes site characterization methods, field demonstration projects, workshops, workshop reports, and training courses.

###### GW-3. DNAPL Characterization and Remediation

- 3a. Research on improved methods for locating and characterizing DNAPLs in the subsurface. This includes geophysical methods and techniques for measuring mass flux from DNAPL source areas.
- 3b. Research on improved methods for remediating DNAPLs in the subsurface. This includes all

possible methods for in-situ treatment of DNAPLs (e.g., thermal, chemical oxidation, surfactant flushing, reactive barriers, enhanced bioremediation, and other methods).

3c. Development and application of DNAPL-related research. This includes field demonstration projects, workshops, workshop reports, and training courses.

#### GW-4. Emerging Issues

4a. Research on improved methods for assessing migration of contaminants from ground water to indoor air. This includes improved site characterization techniques, model verification studies, improved guidelines for use of models.

4b. Research on improved methods for assessing migration of contaminants from ground water to surface water as needed to provide input for evaluation of environmental impacts/risks (see risk issue). This includes improved site characterization techniques.

#### GW-5. Field Characterization - Sampling and Monitoring Methods

5a. Research and development of improved methods for detection and measurement of contaminants in ground water. This includes basic research as well as development and field testing of methods to be used in initial site characterization as well as in long-term site monitoring.

#### GW-6. Long-Term Remedy Performance

6a. Research and development of improved methods for evaluating long-term performance of pump and treat (P&T) systems, including capture zone analysis, evaluation of monitoring effectiveness, optimization methods, etc. This could include improved methods for collection, tabulation, plotting, and statistical evaluation of large data sets.

6b. Research and development of improved methods for evaluating long-term performance of permeable reactive barriers (PRBs). This could include research and development of methods for enhancing performance of PRBs, evaluation of treatment effectiveness, monitoring effectiveness, optimization methods, etc.

6c. Research and development of improved methods for evaluating long-term performance of vertical containment barriers. This could include research and development of methods for verifying barrier continuity, wall embedment and leak detection.

## **II. SEDIMENT RESEARCH NEEDS – OERR Contact Steve Ells**

### **Site Characterization Issues**

#### SED-1. Development of Sediment Contaminant Screening Levels

##### SED-1. Fate and Transport Model Recommendations

What models should be recommended for various common types of sediment sites?

##### SED-2. Measuring Effects of Large Events on Sediment Transport

It is difficult to monitor during some large hydrologic events, especially those which involve ice scour, both because they are not easy to predict, and because of physical dangers. Lacking that, are there practices we can recommend for after-the-fact measuring the effects of these events on sediment movement? (This may be a literature survey question.)

### SED-3. Tools for Locating Debris

What are the best tools for locating and identifying debris (buried and surficial) in sediment (e.g., during evaluation of dredging alternatives)?

### SED-4. Background Issues in Biota and Sediment

What should be the scientific basis for making decisions about background levels in biota and sediment at sediment sites?

### SED-5. Sampling Surface Sediments

e.g., How to sample surface fluff layer?

### SED-6. Ground Water/Sediment Interactions

When should you evaluate GW - Sediment interactions?

### SED-7. Evaluating Past Erosion and Deposition

What suite of empirical methods can we recommend for assessing the extent to which deposits of contaminated sediment are the result of deposition only vs. the result of alternating erosion and deposition? Do we recommend a different suite for different types of water bodies? Where deposits are the result of alternating erosion and deposition, are there empirical methods available to evaluate the horizontal and vertical scale of that movement, or can this only be estimated through modeling? What are common (rates) of erosion and deposition in various environments which are typical of Superfund contaminated sediment sites?

### SED-8. Biota and Sediment Sampling Procedures

### SED-9. Fish Ingestion Rates

What are best practices for selecting fish ingestion rates for risk assessment and selection of cleanup levels?

### SED-10. Chemical Fingerprinting to Tie Risk Drivers to Sources

For contaminants such as PCBs and others which undergo some degree of biodegradation in sediment – is research needed to better tie drivers to sources? Or to risk?

### SED-11. Rates of Contaminant Transport Through Bioturbation

How important is bioturbation in contaminant transport in different habitats? What are common ranges of rates of contaminant transport for common Superfund contaminants in sediment (PCBs, metals, PAHs?) in common Superfund contaminated sediment environments where bioturbation may be a key “transport” element (e.g., estuaries, freshwater harbors and lakes)?

### SED-12. Community Involvement at Large Sediment Sites

How best to collect/know community concerns at big sites?

## **Ecological and Human Health risk Issues**

### SED-13. Prediction of Safe Biota Residue Levels and Population Recovery Times

How can we better predict time to safe contaminant residue levels in biota and biota population recovery times? What are the most uncertain elements of the models we use to make these predictions? What is driving that uncertainty? Some answers will vary by cleanup method (e.g., dredging residuals, rates of natural sedimentation) and other are expected to be universal (e.g., recontamination from uncontrolled sources, large-ranging species.) How can we reduce that

uncertainty in some of those areas?

SED-14. Critical Residue Levels for Bioaccumulative Contaminants

What are the critical tissue residue levels for bioaccumulative contaminants?

SED-15. Cleanup Levels for Eco Risk

How best to determine acceptable cleanup levels for eco risk?

SED-16. Dermal Exposure/Uptake from Sediment

SED-17. Fish Ingestion Rates

What are best methods for determining what fish ingestion rates to use for risk assessments and determination of cleanup levels?

SED-18. Standardized Process to Characterize Human Health and Ecological Risks from Ingestion of PCB-contaminated Fish on a Congener Basis

**Development and Evaluation of Remedies**

SED-19. Monitoring Methods and Protocols

What are the best remedial action and long term monitoring methods for various sediment remedies? Are new methods needed? Are protocols needed?

SED-20. Effectiveness of Containment During Dredging

How effective are silt curtains and screens? What are “best practices” for monitoring and increasing their effectiveness?

SED-21. Dredging Residuals

How can we better predict dredging residuals in different sediment/habitats. What are achievable cleanup levels?

SED-22. Dredging Resuspension

What are the impacts from resuspension caused by dredging? Does dredging result in increased environmental risks to aquatic receptors?

SED-23. Beneficial Use of Dredged Material

How to identify beneficial uses for contaminated sediments at a site?

SED-24. Cost-Effective Treatment Technologies for Dredged Material

SED-25. Effectiveness of In-situ Remedies

How effective are existing MNR and capping remedies? What are theoretical “break-through” times for typical caps and natural deposits overlying contaminated sediment?

SED-26. In-situ Reactive Caps and Enhanced Bioremediation Technologies

SED-27. Designing In-Situ Caps to Accommodate Habitat Restoration/Recovery

SED-28. Enhanced Monitored Natural Recovery

Are there effective measures to enhance MNR? Does thin layer placement speed up natural

recovery? A. Evaluate, to the extent possible, actual effectiveness of thin layer placement as a method to speed up natural recovery at contaminated sediment sites in quiescent environments. B. Evaluate theoretical effectiveness of thin layer placement as a method to speed up natural recovery in quiescent environments, including the following aspects: What are some theoretical combinations of thickness of placed layer + contaminant movement through bioturbation in underlying sediment that result in predicted outcomes?

### **III. SOIL/WASTE RESEARCH NEEDS**

OERR Contact for Landfills/Containment – Ken Skahn

OERR Contact for Mining – Shahid Mahmud

#### **High Priority:**

##### SOIL/WASTE-1. Performance Monitoring for Landfill Caps

Determine appropriate methods and equipment to monitor the performance of landfill caps. What monitoring methods are needed to detect barrier breaches? What modeling methods should be used? How do contaminants affect the long-term integrity of barrier materials? OSWER is revising the landfill capping guidance document issued in July 1989 and will add requirements for monitoring the performance (prevention of infiltration) of installed landfill caps. The information prepared under this project will be the background support needed to support the new requirements.

##### SOIL/WASTE-2. Long-Term Remedy Performance for Containment Systems

For example, persistence of contaminants and their effects if they have been stabilized or solidified; design life of physical barriers, e.g., caps, slurry walls.

##### SOIL/WASTE-3. Management of Landfill Gas

Determine appropriate methods to monitor and measure the gas escaping from landfill units. Determine the point at which measurements would indicate it would be acceptable (based on existing regulations) to vent landfill gas in lieu of collecting the gas for beneficial use or treatment. Determine appropriate collection systems. Determine appropriate technologies for treatment of the collected landfill gas. Determine the point at which collection is no longer required and gas could be vented directly to the atmosphere. How to manage LF gas and understand its movement in capped LFs, and under clay vs. phyto caps

#### **Medium Priority:**

##### SOIL/WASTE-4. Landfills

1. Upgrade guidance; 2. Need data to show if evapotranspiration and capillary barrier covers will work in arid conditions. Need criteria for designing these types of covers.

##### SOIL/WASTE-5. Seismic Considerations for Landfill Caps and Vertical Barriers

EPA has not addressed the need to consider the impact of seismic events in the design of landfill caps and vertical containment barriers. This project would entail the search of literature for relevant research papers, reports on actual impacts to caps, and data to support recommendations on design guidelines for capping landfills in areas subject to seismic events. This information will help to support guidelines developed for the capping guidance document, and determine whether subsequent guidelines are needed for vertical barriers.



#### SOIL/WASTE-6. Evaluation of Alternative Designs and Materials for Caps and Barrier Walls

A newly developed landfill cap design has emerged which shows promise for use in arid environments. The evapo-transpiration cap does not rely on traditional impermeable barriers to prevent infiltration from passing through the cap, but instead relies on the depth of materials in the cap and vegetation to release moisture back to the atmosphere before the moisture can reach the bottom of the cap material. Other designs may also be viable. Information on the performance, durability, and design parameters and minimum standards for these new caps must be collected and analyzed. Performance data and design criteria recommendations for revised capping guidance are needed. New materials for landfill cap and barrier wall construction are emerging on a regular basis. Data is needed on the acceptability of these materials with regard to meeting performance requirements, durability, and relative cost. This project would require review of technical papers, data from independent testing, and consultation with other Federal Agencies (i.e., USACE, BUREC, DOE, etc.) to collect the needed information.

#### SOIL/WASTE-7. Verification of HELP Model

EPA has recommended use of the HELP (Hydrogeologic Evaluation of Landfill Performance) Model in past guidance documents. The HELP Model is used widely for the design of drainage features for landfill caps as well as predicting leachate generation for municipal landfills. There is concern among designers as to the accuracy of the model. This would entail making an assessment of the accuracy of the model in predicting infiltration rates, and recommendations as to the extent it should be used in the future. The effort should also include an assessment of other available models.

#### SOIL/WASTE-8. Mining Site Research

OERR Contact Shahid Mahmud

a. Analysis and Development of Mine Waste Technologies

Short term: analysis/inventory of existing technologies to address mine waste, long-term: development of cost-effective technologies to address mine waste. Mine waste includes all types including uranium. [Note: Mine Waste Technology Program (Butte, MT) is implementing this.]

b. Mapping System/Inventory of Mine-Affected Watersheds

Need for a mapping/database system containing contaminated watersheds resulting from mining; continue using AVRIS to map mine sites.

c. Inventory of Naturally-Occurring High Arsenic

A paper study of where As is naturally occurring at high levels (see USGS conference proceedings May 2002 in Denver)

Potential contacts: NRMRL - Paul Randall, NERL - Jane Denne

d. Develop Predictive Site Characterization Tools for Acid Mine Drainage.

[USGS work may be on-going]

#### SOIL/WASTE-9. Deleted

#### SOIL/WASTE-10. Bioavailability of Metals and Organics from Soils (Human Health and Ecological)

Determine bioavailability of contaminants through human ingestion to support both risk assessment of contaminants in residential and industrial/commercial scenarios and to determine cleanup goals for soil remediation technologies. In particular, assess the bioavailability of lead, mercury, chromium, arsenic and cadmium. Reference doses, benchmark guidance and RfC values need development and communication. Children of different ethnic backgrounds reflect different exposures. Fish advisory values /effects differ among Federal agencies. The question, then, is “If a child, or adult, ingests soil, what is the internal dose relative to the contaminant concentration in the soil?” A core part of this research should be a strategy for relating *in vitro* studies to empirical animal studies to human biomarker/epidemiological data. Develop and evaluate processes to reduce contaminant bioavailability.

Contacts: OERR - Steve Ells, Janine Dinan; Regions 7 & 9

#### **IV. MULTIMEDIA & ANALYTICAL RESEARCH NEEDS**

Analytical Research Needs - OERR Contact Dana Tulis

##### **High Priority**

##### MULTI-1. Statistical Expertise to Support Background Policy

Provide technical expertise for statistical problems related to Superfund site activities and for implementing the new Superfund technical guidance for determining background. [Previously H32] OERR Contact - Jayne Michaud.

##### MULTI-2. Support on-site audits of non-CLP labs

##### MULTI-3. Peer review of new analytical methodologies

On-going need, e.g., PCBs

##### **Medium Priority**

##### MULTI-4. Phytoremediation

Develop improved methods of remediating soil and ground water using vegetation planted and grown in the contaminated areas. Questions include: What are the tolerant plant species, mechanisms of contaminant breakdown, and the rates of cleanup for key contaminants found at Superfund sites?

Contacts: OERR - Scott Fredericks, Steve Ells, Robin Anderson

##### MULTI-5. Analytical Detection Limits for Bioaccumulative Chemicals

The goal of this project is to develop lower analytical detection limits for chemical analyses of known bioaccumulators in water, soil, sediment, and tissue samples. OERR Contact – Steve Ells

##### MULTI-6. Arsenic and Mercury Research

Short term - engineering bulletin. Long term - if there are technologies on the horizon, it would be good to know more about them. [Note: Have fact sheets on Pb remediation methods - what we have learned. Need to know for As and hg what technologies will and won't work] FY02 note: NRMRL suggests that OERR follows up with Paul Randall, NRMRL. DOE has done a number of studies/demos on cleanup of Hg-contaminated soils. There were discussions in Denver (week of May 7) about cleanup of Hg-contaminated soils. Robert Puls in Ada is contact for As-contaminated groundwater. OERR contact - Robin Anderson

#### MULTI-7. Dioxin Research

Depending on the results of the reassessment, e.g., current technologies may be unable to reach new levels.

#### MULTI-8. Support of sample preparation for high concentration analyses

OERR Contact - Dana Tulis

#### **Not yet prioritized:**

#### MULTI-9 [new] Selected Ion Monitoring

There has never been a statistical study of the ultimate detection levels for SIM. The program needs ORD to determine the sensitivity for the VOCs and Semivols in the new contract. OERR Contact - Dana Tulis

#### MULTI-10 [new] Holding Times

The program needs a better understanding of what holding times are justified by science. Both a lit review of existing studies and actual studies would be useful. OERR Contact - Dana Tulis

#### MULTI-11 [new] Method for ICP/MS

The program needs a method to be developed and published for soil analysis with ICP/MS in ILM 5.2. OERR Contact - Dana Tulis

#### MULTI-12 [new] Sampling for Chemical Weapons

The program has a need for research regarding how to sample for chemical weapons, what methods to use, what screening tools are available, and the appropriate detection levels. OERR Contact - Dana Tulis

### **V. HUMAN HEALTH RESEARCH NEEDS – OERR Contact Jayne Michaud**

#### **High Priority**

#### HH-1. Reduce Uncertainties Associated with Dermal Exposure Assessments - Water Exposure

For water exposures is model in Part E over or underestimating actual absorption, or are assumptions reasonably accurate? Additional research is necessary to determine the absorption of lipophilic contaminants (e.g. PCBs, dioxins) through the skin barrier. (Part E, is Part E of Risk Assessment Guidance for Superfund (RAGS), and addresses dermal exposures. This is Superfund's current draft guidance on dermal risk. It is considered an extension of the ORD guidance on dermal, known as "Dermal Exposure Assessment" or "DEA".)  
OERR contact: Dave Crawford

#### HH-2. Dermal Exposure Model

Refine (Part E) or develop model for estimating dermal absorption of contaminants from soil, using permeability coefficients. Consider issuing as an update of DEA or Part E, and evaluate efficacy of ongoing methodology developed for reoccupancy of buildings in the vicinity of the World Trade Center. OERR contact: Dave Crawford

#### HH-3. Determine Dermal Toxicity Effects and Develop Dermal Toxicity Values

For contaminants without dermal toxicity values in IRIS, expand the database of toxicity values. For noncancer toxicity, expand the database of values (i.e. RfDs) for subchronic and acute exposures, as

well as chronic RfDs. Develop values for “point of contact (on skin) toxicity”, including PAHs. Recommend that such values loaded into OERR’s database of NCEA peer reviewed toxicity values. OERR point of contact: Dave Crawford

#### HH-4. Develop Methodology for Integrated Assessment for Residential Exposures

For various media, including vapor intrusion (indoor air), dermal exposure to building surfaces (as well as soil and water), and soil ingestion. Consider an Update to Part E for dermal, use of the World Trade Center reoccupancy assessment and the recent Vapor Intrusion Guidance for the Integrated Assessment. OERR point of contact: Jayne Michaud and Dave Crawford (dermal).

#### HH-5. Improve Dose-Response Assessment

Improve dose-response assessments for contaminants occurring frequently at Superfund sites, considering the use of additional pharmaco-kinetic physiological models. When scientifically appropriate develop special assessments applicable to children and women, as sensitive subpopulations. When appropriate, provide methodology for assessing more sensitive or highly exposed subpopulations. Recommend that such values be considered for inclusion in IRIS, or, alternately, the PREV database. OERR point of contact: Jayne Michaud

### **Medium Priority**

#### HH-6. Reduce Uncertainties Associated with Dermal Exposure Assessments - Soil Exposure

Generate and interpret additional experimental data to assess reliability of Part E’s estimation of dermal exposures to soil. OERR contact: Dave Crawford

#### HH-7. Support for the Exposure Factors Handbook

Update and expand assumptions and supporting justification for human health exposure assumptions, including soil ingestion. Questions: Will this provide sufficient information for use in Probabilistic Risk Assessments? OERR contact: Jayne Michaud, Steve Chang

## **VI. ECOLOGICAL RESEARCH NEEDS – OERR Contact David Charters**

### **High Priority**

#### ECO-1. Define Ecological Significance

Goal is to clearly define and describe ecological significance and to determine what levels of population and community effects are generally acceptable; i.e., will a 20% reduction in a specific endpoint still sustain a functioning, healthy ecosystem? How does EPA determine that: 1) the observed or predicted adverse effects on a structural or functional component of the site’s ecosystem is of sufficient type, magnitude, areal extent, and duration that irreversible effects have occurred or are likely to occur, and 2) these effects appear to exceed the normal changes in the structural or functional components typical of similar unimpacted ecosystems?

#### ECO-2. Balancing the Benefits of Remedial Action vs. Destruction of Valuable Habitats

The goal of this project would be to develop criteria and provide guidance on how to determine when there is more benefit to the existing ecosystem from leaving soil or sediment contamination in place and preserving the current habitat (although stressed), versus a destructive remedy that removes the contamination and destroys the current habitat. How do you value a habitat that is functioning, but at less than optimal levels, vs. the short to long-term impacts on destroying the same habitat and then trying to restore it?

ECO-3. Develop predictive models for determining the potential population level effects

How much sediment toxicity is needed before anyone can predict that there will significant effects on the population of concern; e.g, how many bass or mink or kingfishers can be killed before the mortality levels is expected to impact the ability of the population of biota to sustain itself at a healthy level in the area impacted by the site.

ECO-4. Weight of Evidence Approach for Ecological Effects/Cleanup Levels

There are published papers on this process, should SF adopt a similar process for consistent use at our sites?

ECO-5. Support Development of Eco-SSLs for Mammals, Birds, Plants, and Soil Invertebrates

ECO-6. Continue to support and maintain the ECOTOX database

ECO-7. Design toxicity testing procedure to develop toxicity reference values for non-eco-SSL contaminants

Utilize the criteria developed by the Ecological Soil Screening Level (Eco-SSL) workgroup to design a toxicity testing procedure to meet these criteria in order to generate toxicity reference values (TRVs) for additional contaminants not being addressed by the Eco-SSL workgroup or for which TRVs are lacking.

**Medium Priority**

ECO-8. Determine Bioavailability of Chemicals for Different Media

The central question is how does one relate concentration of a contaminant in a medium (even the medium for animal dose/response studies) to the delivered or internal dose. Answering this question would reduce a major source of uncertainty in risk assessments.

ECO-9. Develop a methodology to evaluate the inhalation exposure pathway for mammals

ECO-10. Development of Recommended Performance Criteria to Measure the Success of Wetlands Restoration/Creation

ECO-11. Support Wildlife Research Strategy

ECO-12. Develop Terrestrial Risk Assessment Models for Various Habitats from Deciduous Forests to Deserts.

ECO-13. Develop Toxicity Testing Methodologies for Amphibians, Reptiles, and Microbial communities.

ECO-14. Develop an approach for incorporating dose response information into ecological risk assessments that go beyond the hazard quotient approach

How can the likelihood of risk be quantified when the hazard quotient is greater than 1? Develop an approach for conducting uncertainty assessment using site-specific case studies.

ECO-15. Develop tools and methods to better characterize the ecological exposure and effects of multiple chemicals, i.e., mixtures.

ECO-16. Develop an approach for assessing the exposure and effects of contaminants to corals

## **Oil Program Research Needs**

### **OERR Contacts David Evans/Barbara Davis**

#### **FY2003**

- \*1. Technical Support for Dispersant Effectiveness Test  
Completed new protocol and support for Federal Register changes in FY2002; in FY2003, verification of test results in response to comments if necessary
- \*2. Development of Surface Washing Effectiveness Test  
Develop protocol to measure ability to remove oil from solid material, such as sand, gravel, and soil
- \*\*3. Orimulsion®
  - A. Fate and Toxicity Changes  
Biodegradation and changes in toxicity of product and surfactants in freshwater and saltwater environments during degradation; complete report
  - B. Development of Enhanced Oil Spill Model (with capability for evaluation of spilled Orimulsion®)
    - 1) Begin developing background information and mathematical expressions for Oil Spill 2) Model simulating behavior of Orimulsion® in aquatic environments
- 4. Environmental Effects of Dispersants and Dispersed Oil
  - A. Energy Dissipation Rate–Ohmsett study
  - + B. Toxicity and Effects of Dispersants and Toxicity and Physical Effects of Oils and Dispersed Oils  
Includes long-term toxicity testing, mesocosms
  - C. Effectiveness of Dispersants  
Comparative study using flask tests with different oils under various conditions; effectiveness under different conditions of weathering, temperature, waves, salinity  
Possible interagency study
- 5. Fate and Transport Modeling of Dispersants, Oil, and Dispersed Oil in Nearshore Environments
  - A. Interim Report on Model  
Report on selection and analysis of variables for exposure assessment
  - B. Upgraded Prototype Multicomponent Model for Fate and Transport of Dispersants, Oil, and Dispersed Oil  
(Model linked with chemical property estimator; includes models for action of dispersants on oil slicks, dissolution of chemical components from oil slick and dispersed oil droplets, and transport)
    - 1) Compilation of NOAA buoy data
    - 2) Develop oil composition database
    - 3) Verification of model and validation with selected data sets

- 4) Complete development, documentation and user interface of model so that it is suitable for pilot testing
- C. Report on documentation of testing, incorporation of results from interim model, implementation of user interface and training; Pilot Testing
- D. Develop Users' Manual
  
- 6. Bioremediation
  - A. Design Manual on Bioremediation of Oil Spills in Salt Marshes--peer review, complete
  - \*,\*\*B. Bioremediation Products in Freshwater and Saltwater  
Finalize protocol (This testing aids EPA's compliance with the Clean Waters and Estuaries Act of 2000.)
  - \*\* C. Bioremediation Literature Search and Review--peer review, complete  
(To aid in compliance with Clean Waters and Estuaries Act of 2000.)
  - D. Effect of Resource Ratio on Biodegradation of Oil  
Optimize N/P/C ratio for future field study
  - E. Effect of Dispersed Oil on Biodegradation in Cold Climates  
Initiate laboratory research
  
- \*\*7. Environmental Fate and Effects of Vegetable Oils and Animal Fats
  - A. Emulsification of Vegetable Oils/Animal Fats, Petroleum Oils, and Non-Petroleum Oils
    - 1) Complete interim report
    - 2) Conduct additional studies to develop reproducible protocol
  - B. Anaerobic Treatment of Vegetable Oils--Feasibility of treatment for spill response  
Determine biodegradation rates and if possible breakdown products in bench scale study
  - C. Mechanism of Aerobic Degradation of Vegetable Oils
    - 1) Determine biodegradation rates and if possible breakdown products--initiate study
    - 2) Toxicity of vegetable oils and breakdown products formed by aerobic degradation--begin study
  
- 8. Spills of Opportunity  
Develop protocols for comparing cleanup technologies--conduct further statistical analysis, develop new statistical approaches  
Application of new methods to cleanups; report, communicate findings to oil research and response communities

## **FY2004 Oil Program Research Priorities**

- \*1. Development of Surface Washing Effectiveness Test  
Round robin testing; characterize oil components removed by surface washing agents; complete report
  
- \*\*2. Characteristics and Ecological Effects of Orimulsion®, and Assessment of Strategies for Cleaning Up or Treating Orimulsion® Spills in Freshwater Environments
  - A. Physical Properties of Orimulsion® in Freshwater, Brackish Water, and Saltwater; verify properties, conduct limited testing if necessary [Started in 2002; further testing may be needed in 2004]
  - + B. Toxicity of Orimulsion® on Benthic Sediment Organisms
  - + C. Fate and Toxicity Changes--additional testing if necessary
  - D. Utilize mathematical approaches developed in FY03 (Item 3.B.1) to adapt oil spill model for simulation of Orimulsion<sup>(R)</sup> spills under varying environmental conditions

Begin development of model

3. Continue Development of Enhanced Oil Spill Model
  - A. Report on documentation of testing, incorporation of results from interim model, implementation of user interface and training; Pilot Testing
  - B. Develop Users' Manual
  - C. Begin adaptation of the model for vegetable oil spills
- \*\* 4. Environmental Fate and Effects of Vegetable Oils and Animal Fats
  - A. Anaerobic Treatment of Vegetable Oils–Pilot Study
  - B. Anaerobic Degradation of Vegetable Oils–Field Study  
Initiate study in conjunction with #4 below
  - C. Mechanism of Aerobic Degradation of Vegetable Oils
    - 1) Continue study on biodegradation rates and products
- + 2) Continue study on toxicity of vegetable oils and breakdown products formed by aerobic degradation
5. Field Studies on Ecological Effects of Oil Spills and Dispersed Oil  
Begin Field Study on effects of oil spills on flora and fauna in water column and sediments of Canadian lakes
6. Bioremediation
  - A. Effect of Resource Ratio on Biodegradation of Oil  
Field Study
  - B. Biofilms  
Initiate study of biofilms and the interaction of organisms at oil/water and soil/water interfaces, how microorganisms degrade oil, and how microorganisms interact with oil that is sorbed to particles
  - C. Effect of Dispersed Oil on Biodegradation in Cold Climates  
Continue research; interim report
  - D. Effect of Non-Dispersed Oil on Biodegradation in Cold Climates  
Begin research; interim report
7. Comparative Analysis of No Action, Mechanical Recovery, and Dispersant Application Scenarios  
  
Modify Oil Spill Model to include simulations of various response options  
Complete comparative evaluation on use of these measures with modified Oil Spill Model for simulations of various response models
8. Transport in a Tidal Marsh–Field Study to provide data to support Oil Spill Model

## **FY 2005 Oil Research Priorities**

1. Multimedia Enhancement of the Oil Spill Model  
Begin development of linkages between oil spill model and air model(s), aquatic food chain models with linkages to uncertainty analysis processing
  - A.) Use EPA/ORD-developed modeling framework to allow linkage of various models (the oil spill model, surface water flow and transport models, air models, etc.)
  - B.) Use the framework's sensitivity and uncertainty analysis capabilities to assess most significant



sensitivities and uncertainties of the model.

C.) Complete adaptation of model for vegetable oil spills

2. Field Studies on Ecological Effects of Oil Spills and Dispersed Oil

Continue field study on effects of dispersed oil on flora and fauna in water column and sediments of Canadian lakes

3. Anaerobic Degradation of Vegetable Oils—Continue Field Study

4. Simulation Model Studies of Orimulsion® Transport—Complete Enhanced Oil Spill Model with capability for evaluation of spilled Orimulsion®

A.) Revise User's guide and supporting databases with information and data needed for Orimulsion<sup>(R)</sup> transport

B) Perform comparative assessment of response techniques for Orimulsion<sup>(R)</sup>

5. Biofilms

Continue study of biofilms and the interaction of organisms at oil/water and soil/water interfaces, how microorganisms degrade oil, and how microorganisms interact with oil that is sorbed to particles

### **FY 2006 Oil Research Priorities**

1. Multimedia Enhancement of the Oil Spill Model

Continue developing linkages between oil spill model and air model(s), aquatic food chain models with linkages to uncertainty analysis processing and GIS databases, in cooperation with other units of ORD to link to existing models; complete report on revised model

\*\*2. Environmental Fate and Effects of Vegetable Oils and Animal Fats

Innovative Ways to Manage Non-Petroleum Oil Spills in Freshwater and Saline Environments in Cold and Temperate Climates

Initiate Field Study

### **FY2007 Oil Research Priorities**

1. Multimedia Enhancement of Oil Spill Model

A.) Complete development of Oil Spill Model linked with multimedia framework and uncertainty analysis

B.) Evaluate linked modeling system using a prototype problem

2. Effectiveness of Clay-Oil Flocculation Plus Nutrient Addition on Treating Oil Slicks on Lake Surfaces

3. Environmental Effects on Non-Petroleum Oil Spills in Cold Climates—Complete Report

\*On National Contingency Plan Product Schedule

\*\*Related to recent statutory requirements

+ Need additional testing

NOTE: Lists are subject to change.



## **Appendix E - Unfunded Research Needs**

### **Contaminated Sediments**

Over the past several years, ORD has shifted resources to allow a substantial research effort on contaminated sediments. Additional resources would allow us to fill in some gaps and/or accelerate existing efforts to strengthen the science foundation for impending decisions on contaminated sediment sites.

Mathematical model framework development would be expanded for large receiving water bodies (transportable to large coastal systems) with tributary inputs from multiple Superfund sites contaminated with multiple anthropogenic substances, including PCBs and mercury. The multimedia modeling construct provides the relative impact of contaminated sediments and inputs (tributary and atmospheric), while focusing on monitored natural recovery for the receiving water body. Forecasts of differing alternatives provide prioritization for actions in watersheds and the atmosphere component, where dredging and capping options are considered for tributaries, producing both lakewide and local improvements. Forecasts are provided for concentrations of water, sediment, and fish tissues. Included in the more complex modeling frameworks are linked and/or coupled atmospheric, hydrodynamic, sediment transport and fate, water quality, and food chain bioaccumulation models. Three levels of model constructs with varying degrees of spatial and temporal resolution need to be developed. The initial unfunded effort was to document a low, spatial resolution model (Level 1 - Screening) which provides remedial forecasts in a large receiving water body expressed as fish tissue concentrations of PCBs from a food chain bioaccumulation model. The initial unfunded effort planned to use the Lake Michigan ecosystem as an illustrative example.

Characterization research could be expanded to include field evaluation of sediment sampling methods that allow collection of very near surface sediments without disturbance. Such samples are important for studies that involve age-dating, bioturbation depth, surface-area weighted concentration averaging, and model and remedy performance evaluation. This research was scheduled to begin in FY03, but was delayed because of a 1-year funding reduction. With additional resources, a more substantial research effort could be started to evaluate an optical remote sensing technique that might be used as a screening tool, allowing better targeting of more time- and cost-intensive sediment sampling both for characterization and remedy performance evaluation.

Research is being proposed to expand the number of biological indicators that can characterize impairments due to contaminated sediments and to rapidly assess responses to remedy implementation. The proposed research includes evaluation of small, short-lived fish pre- and post-remediation to determine if changes can be detected sooner in these fish than in longer-lived game or bottom dwelling fish. In addition, research will be conducted to assess the effectiveness of remediation operations by conducting pre- and post-remediation toxicity assessments, bioassessments (periphyton, macroinvertebrates and fish monitoring), and toxicogenomics assessments. Early detection of tissue burden and toxicity reductions provide confidence in modeled predictions and ultimate remedy performance that will be reflected later in the native biota. We have proposed to use an emerging tool in stream ecology, stable isotope analysis, to develop a mechanistic understanding of energy and material flux within PCB contaminated streams and lakes and their food webs. Stable isotopes techniques have been used to track biomagnification of PCBs in marine and lake food webs but similar applications in streams have not been explored. We also hypothesize that PCBs cycling in littoral (i.e., near-shore) and pelagic (i.e., open water) food webs of PCB contaminated sites may delay natural recovery. An analysis

of food web dynamics and biomagnification pathways would improve our ability to forecast recovery and interpret current data on PCB levels in fishes of concern. We propose to evaluate existing data sets for parameterizing a food web model of Lake Hartwell. Other ecological tools will be assessed for their ability to monitor real-time bioavailability of contaminants as they partition across media.

Research could be initiated on community level effects of contaminated sediments to support ecological significance issues in ecological risk assessment. Initially, the research would utilize population models to assess how contaminant stresses generally affect ecological populations, then would model individual sites to determine how well the ecosystem responses at various levels of scale can be predicted. Tools and indices for assessing community level effects would also result from this research.

Increased resources are proposed for the theme of research on community involvement and risk communication at contaminated sediment sites. Research would evaluate more effective methods and tools to describe, summarize, and present complex technical data to communities. Better community outreach tools would be developed that can be applied to large geographic sites with multiple diverse communities each with its own interests and concerns. Better methods are also needed to develop site-specific exposure factors based on the habits of local communities which could reduce reliance on the use of national default assumptions that might not reflect local customs or conditions. Methods are needed on developing ways to determine how various societal/cultural values and practices are impacted by contaminated sediments or cleanup activities. Finally, research would be conducted to assess the effectiveness of risk communication and community involvement practices.

## **Brownfields**

The redevelopment of toxic and hazardous waste contaminated sites is a global concern that requires an integrated approach to mitigate the risks to human health and the environment. One report by the U.S. Conference of Mayors identified 19,000 brownfields sites representing more than 178,000 acres of land. The Small Business Liability Relief and Brownfields Revitalization Act of 2002 authorizes funding for brownfields redevelopment implementation and for related research and development. Because the planning and budgeting activities focus two years ahead, the President's Budget for FY2004 does not include research specific to Brownfields. ORD has conducted a series of meetings with the Office of Brownfields Cleanup and Redevelopment to identify research that would facilitate responsible site redevelopment.

Brownfields projects are carried out by a diverse range of organizations, including local governments, ad hoc stakeholder groups, and private developers, which have differing knowledge of and access to site characterization and remediation tools and technologies. Brownfields grant recipients identify this information gap as a key barrier to project implementation. The research described below is designed to develop, package, and deliver information on tools and technologies for redevelopment. The research is complemented by site-specific technical support. States are key partners in identifying projects and transferring results.

The proposed program has five themes: enhanced characterization tools; decision support tools; "suitably clean" remediation approaches; publications and training; and site-specific technical support.

The enhanced characterization component will build on user-friendly tools developed for Superfund, RCRA, LUST, and oil spill projects. The first products would include on-line calculators to evaluate common brownfield problems, including DNAPLs and vapor intrusion. The decision support tools will

integrate environmental, social, and economic aspects of selecting and achieving a suitable property use. Initial products include modules on conceptual modeling of the project, business plan development, and best practice case studies. A series of workshops will be used to assess and select economic tools, management and marketing strategies, risk communication, and risk management options.

Ecological protection/restoration and sustainability are underlying values in Brownfields decision support. The program includes development of a science foundation for integrating ecological values and ecosystem services into brownfields redevelopments. Media will be developed to better inform practitioners of the types of best practices that have been considered and applied elsewhere. Further, through collaboration with a willing partner, a pilot will be initiated to demonstrate how sound science can improve integration of ecological values into Brownfields redevelopment, thereby supporting and enhancing societal benefit and value.

Remediation of Brownfield sites is similar to remediation in other cleanup programs, with three important exceptions: (1) low cost is paramount in attracting all the partners needed to redevelop the property; (2) timeliness is critical to success; and (3) cleanup goals can be more flexible. The first two exceptions tend to be barriers to success, while the third can be a significant advantage. The proposed work will focus on adapting cleanup technologies from other programs and on use of creative approaches that may include recycling and waste-derived products.

The publication and training theme will tailor products for the Brownfields audience and will be developed in conjunction with the Interstate Technology and Regulatory Council's (ITRC) Brownfields Team. Initial products include guidance on interpretation of model outputs; compilation of economic tools; a primer on project components and available ; and a guide on contaminant plume behavior. Site-specific technical support would allow Brownfields project staff to access ORD's technical support centers for Monitoring and Site Characterization, Ground Water, and Engineering. Reviews by these centers will help to ensure the technical adequacy and suitability of plans and reports generated by project staff and their consultants/contractors.

## **Mining**

Mining research was identified as a priority by a number of Regional Offices and OSWER. There are site characterization and remediation issues that are of particular importance, as well as issues of ecological assessment. Some human health issues also exist.

In the area of management of mine waste problems, ORD sees the most critical research needs being to: (a) prevent the formation of acid mine drainage (AMD) and (b) provide more cost-effective techniques for treatment of AMD-contaminated ground water and surface water.

Mining remediation demonstrations are being done under the SITE program. Superfund site-specific and technology transfer technical support will also continue to be given on mining sites through ORD technical support centers. The Rocky Mountain Regional HSRC has mining sites as its main focus area (see Appendix F).

Contaminated Sites research will continue on mine waste issues where techniques applied to other situations could potentially be readily applied there. Ground water research is being conducted on the application of permeable reactive barriers to highly-acidic contaminated waters. Soils/land research on metals immobilization is focused on effective, low-cost processes for sites of large area and directly

impacts mine site clean up decisions. This research addresses bioavailability issues, too. Pilot and full-scale technology demonstration research on AMD prevention and GW and SW treatment will continue to be pursued under the Mine Waste Technology Program.

If the mining program is continued for ORD Superfund research at the limited levels described above, then the following research needs that have been identified by OSWER and the Regions will not be addressed. Note that this list just covers the highest priority OSWER/Regional mining research needs and activities that we believe ORD could do.

- Development of hyperspectral remote sensing data analysis methods and models for the identification, assessment, characterization, prioritization, and monitoring of mining wastes and mine-impacted ecosystems.
- Development and application of improved ecological tools and approaches for mining waste such as toxicity testing, evaluation of ecological impacts, indicators, genetic, and non-native species research.
- Expansion (e.g., to include surface water in addition to ground water) and field validation of previous work to “fingerprint” contaminant sources and identify parameters and strategies to detect leachate migration from hard rock mining waste.
- Development of multimedia model applications for mine waste, including addition of mining source term and more metals chemistry work.
- Research to take promising AMD prevention processes from bench scale to pilot scale so that they can then be tested in the field through other programs such as the Mine Waste Technology Program.
- Develop and evaluate techniques to assess risk and toxicity to ecological organisms from acidic drainage. Develop methods to assess the impacts of acidic drainage on stream quality.
- Ecosystem restoration research, including surface reclamation work.
- Coal mining issues are beyond the scope of this proposal although some findings would be applicable.

Some work related to remote sensing and ecological tools is ongoing under other goals and may address some of the needs in this list.

## Appendix F - Grants Programs

This appendix describes two grants programs that are supported by the ORD Superfund Research Program.

### Superfund Hazardous Substances Research Centers

Under the Superfund Amendments and Reauthorization Act (SARA) which amended the CERCLA, EPA has the authority to establish a comprehensive Federal program of research, development, demonstration, and training to promote alternative and advanced treatment technologies and to improve the scientific capability to detect, assess, and mitigate risks associated with all major aspects of the manufacture, use, and disposal of hazardous substances. Under this authority ORD/NCER has selected five Hazardous Substance Research Centers (HSRCs) to provide research, technology transfer and community outreach that address hazardous substance problems of concern to the ten EPA regions as described below.

#### ***Center for Hazardous Substances in Urban Environments (Lead: Johns Hopkins Univ)***

This center focuses on environmental problems specific to Regions 1, 2, and 3 with “Urban Livability” as a strategic priority. Research will address the following subjects:

- Potential exposure pathway from airborne particles
- Transport and fate of toxic metals and organic contaminants in the subsurface soil and ground water
- Improvement of methods for assessing Cr environmental toxicity
- Remediation of chlorinated solvents

#### ***Hazardous Substance Research Center/South and Southwest (Lead: Louisiana State Univ)***

HSRC/S-SW will focus on environmental problems of concern to Regions 4 and 6, particularly on issues related to the management of contaminated sediments. Major research areas are:

- Evaluation of the bioavailability of desorption-resistant contaminants
- In-situ approaches for containment and treatment of contaminated sediments
- Assessment of containment losses during removal and episodic storm events
- Evaluation of phytoremediation for remediation of wetlands

#### ***Midwest Hazardous Substance Research Center (Lead: Purdue Univ)***

This center will focus on environmental problems specific to Regions 5 and 7 particularly contamination with toxic metals and organic compounds including TCE, PCB, PAH, and BTEX.

Research will focus primarily on:

- Development, optimization, and assessment of managed natural remediation systems for the restoration of contaminated water, soil, and sediments.
- Development of mathematical models to predict the efficiency of remediation.
- In-situ treatments for intrinsic and enhanced remediation

#### ***Rocky Mountain Regional Hazardous Substance Research Center (Lead: Colorado State Univ).***

The Center will focus on the environmental impact caused by mining a major concern in Region 8.

Proposed research areas are:

- Recovery of ecosystem affected by mining pollution
- Metal removal capability of passive bioreactor systems
- Soil/sediment interactions of inorganic forms of arsenic and selenium

***Western Region Hazardous Substance Research Center (Lead: Oregon State Univ)***

HSRC/W will focus on environmental problems of concern to Regions 9 and 10 such as subsurface contamination with volatile organic chemicals with an emphasis on chlorinated solvents and MTBE.

Proposed research areas are:

- Anaerobic dehalogenation of chlorinated aliphatic hydrocarbons (CAHs)
- In-situ treatment of ground water contaminated with CAHs and MTBE
- In-situ abiotic treatment of CAHs using catalytic destruction methods
- Study of the kinetics of contaminants' desorption/dissolution

All five Centers have proposed to develop comprehensive technology transfer and outreach programs to integrate new knowledge and technology into use by industry, communities, and government.

**Science to Achieve Results (STAR) Grants**

ORD has a significant research grants program to support academic research. While trust funds resources are not used to support these grants, some of them are relevant to Superfund, Underground Storage Tanks, and Oil Spills. ORD makes an effort to capture relevant grant reports of interest to OSWER in annual products lists.

**Superfund Minority Institution Research**

In FY02 ORD issued a competition for minority institutions who wish to conduct research on Superfund contaminated site issues. Six selected projects are in the process of being funded. Superfund funding for minority institution research ends in FY03; in future years follow-on research will be reflected in a different MYP.